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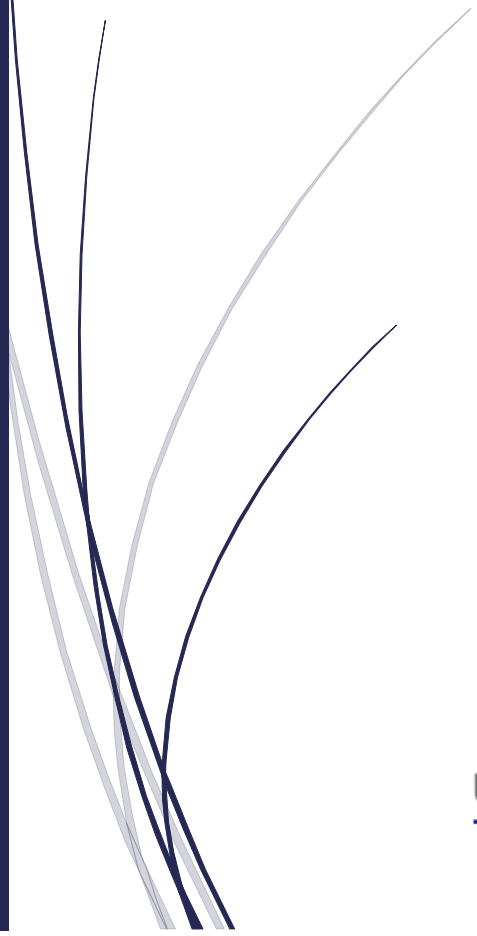
Dry pasta

Product Environmental Footprint Category Rules (PEFCR)

Draft for public consultation

Rev. 16/12/2015



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ACRONYMS

AIDEPI: Associazione delle Industrie del dolce e della pasta italiane

CPA: Classification of product by activity

CPC: Central Product Classification

DQR: Data Quality Rating

EC. European Commission

ELCD: European reference Life Cycle Database

EF: Environmental Footprint

EFTA: European Free Trade Association

EOL: End of Life

EPD: Environmental Product Declaration

FAO: Food and Agriculture Organization of the United Nations

EU: European Union

IES: International EPD System

ILCD: International Reference Life Cycle Data System

ISO: International Organization for Standardization

JRC: Joint Research Centre

LCA: Life Cycle Assessment

LCI: Life Cycle Inventory

LCIA: Life Cycle Impact Assessment

NACE: Nomenclature statistique des activités économiques

NGO: Non-governmental organization

OEF: Organisation Environmental Footprint

OEFSR: Organisation Environmental Footprint Sector Rule

PCR: Product Category Rules

PEF: Product Environmental Footprint

PEFCR: Product Environmental Footprint Category rules

PM: Particulate matter

PP: Polypropylene

PWG: Packaging Working Group

SC: Steering Committee

TAB: Technical Advisory Board

TS: Technical Secretariat

169 UNAFPA: Union de Associations de Fabricants de Pates Alimentaires de la Union Européenne (Union
170 of Organisations of Manufacturers of Pasta Products of the EU)

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INTRODUCTION

The Product Environmental Footprint (PEF) Guide provides detailed and comprehensive technical guidance on how to conduct a PEF study. PEF studies may be used for a variety of purposes, including in-house management and participation in voluntary or mandatory programmes.

This PEFCR shall be used in parallel with the PEF Guide. Where the requirements in this PEFCR are in line with but at the same time more specific than those of the PEF Guide, such specific requirements shall be fulfilled.

The use of the present PEFCR is optional for PEF guide in-house applications, it is recommended for external applications without comparison/comparative assertions, while it is mandatory for external applications with comparisons/comparative assertions.

1. GENERAL INFORMATION ABOUT THE PEFCR

1.1 TECHNICAL SECRETARIAT

In Figure 1 the members of the Technical Secretariat of the PEF pilot on pasta are listed.

Figure 1 - Members of the Technical Secretariat

Logo	Name of organisation	Activity	Website
UN.A.F.P.A.	UN.A.F.P.A.	Association	www.pasta-unafpa.org
Barilla	Barilla G. e R. Fratelli S.p.A.	Manufacturer	www.barillagroup.com
pastaZARA	Pasta Zara S.p.A.	Manufacturer	www.pastazara.it
Garofalo	Pastificio Lucio Garofalo S.p.A.	Manufacturer	www.pastagarofalo.it
DIVELLA	F. Divella S.p.A.	Manufacturer	www.divella.it
Di Martino	Pastificio Di Martino Gaetano & F.lli Spa	Manufacturer	www.pastadimartino.it

The technical secretariat is under the lead of the Union of Organisations of Manufacturers of Pasta Products of the EU (UN.A.F.P.A.). The contact persons of this pilot is Luigi Cristiano Laurenza (UN.A.F.P.A. Secretary general).

The other members of the technical secretariat are industry representatives.

1.2 CONSULTATION AND STAKEHOLDERS

The PEF pilot on pasta generation includes stakeholders throughout all stages of the process, the supply chain and neighbouring business sectors, as well as non-governmental organisations and industrial associations.

The stakeholders have access to this PEF pilot via the following website:

https://webgate.ec.europa.eu/fpfis/wikis/display/EUENVFP/PEFCR+Pilot%3A+Pasta

A first consultation was held from October 31st to December 15th, 2014. The physical meeting took place on November 14th, 2014, in Brussels. The minutes of the meeting are available in the Stakeholder space of the Wiki.

At the time the present document was drafted 80 stakeholders were registered in the stakeholder workspace of the pilot. Some information about the stakeholders is reported in Figure 2 and Figure 3.

Figure 2 – Geographical distribution of stakeholders

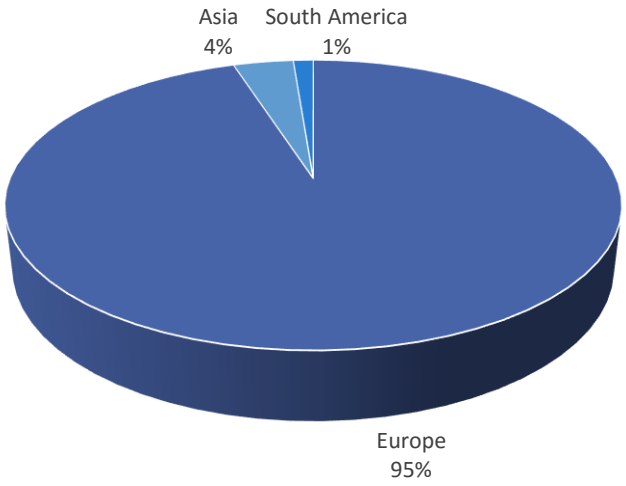
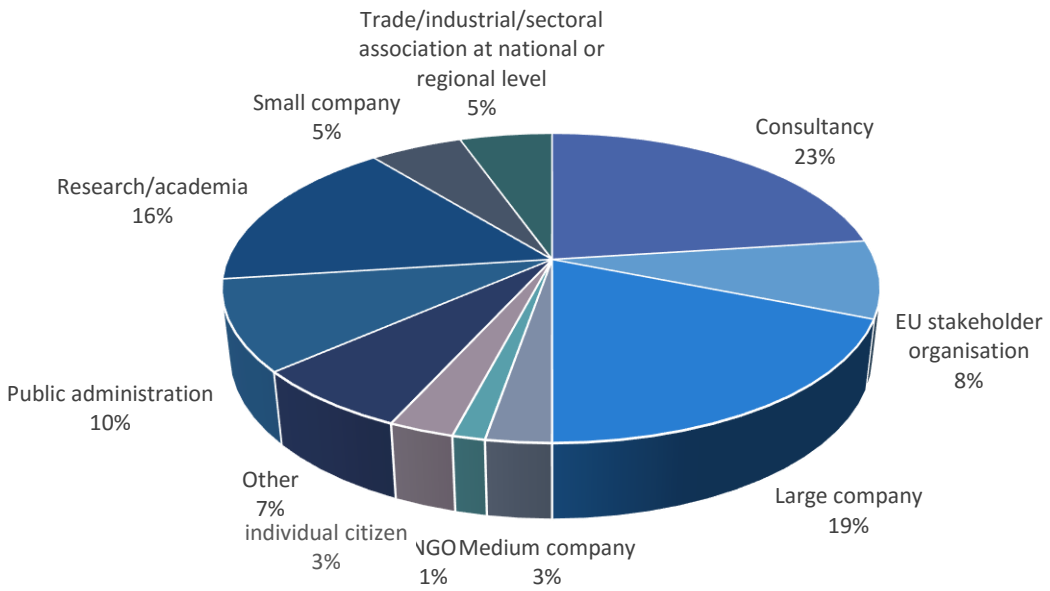


Figure 3 - Typology of stakeholders



1.3 DATE OF PUBLICATION AND EXPIRATION

Version number: Draft version for 2nd consultation

Date of publication/revision: XX XX XXXX

Date of expiration: 4 years after the date of publication

1.4 GEOGRAPHIC REGION

These PEFCR are developed for dry pasta sold in the European Union (EU 28).

1.5 LANGUAGE(S) OF PEFCR

The present original of the PEFCR is in English.

The original in English supersedes translated versions in case of conflicts.

2. METHODOLOGICAL INPUTS AND COMPLIANCE

The PEFCR is intended to be in conformance with the following documents:

- Product Environmental Footprint (PEF) Guide [1]
- Guidance for the implementation of the EU Product Environmental Footprint (PEF) during the Environmental Footprint (EF) pilot phase v. 4.0[2]

PCR for pasta exist also in the context of the International EPD System (www.environdec.com)[3]

In the document *"Dry pasta. Product Environmental Footprint Category Rules (PEFCR). Rev. 25/06/2015"* drafted by the Technical Secretariat and approved by the Steering Committee, the PCR of the International EPD System were reviewed and compared to the PEF guide.

The outcome of the review is that the present PEFCR cannot be totally aligned with the PCR for pasta of the International EPD System because of major differences for several aspects. For further details are reported in the document *"Dry pasta. Product Environmental Footprint Category Rules (PEFCR). Rev. 25/06/2015"*

The PCR of the IES were however used as starting point and as source of information in the development of the present PEFCR.

[1] European Commission (2013). "Annex II: Product Environmental Footprint (PEF) Guide to the Commission Recommendation on the use of common methods to measure and communicate the life cycle environmental

performance of products and organisations (2013/179/EU)."

[2] European Commission (2014) Product Environmental Footprint Pilot Guidance (version 4.0, May 2014)

[3] Environdec, 2013. PCR 2010:01 Uncooked pasta (Version 2.01). Available at http://www.environdec.com/en/PCR/Detail/pcr2010-01#.Vkrw6_kveUk

3. PEFCR REVIEW AND BACKGROUND INFORMATION

3.1 PEFCR REVIEW PANEL

The Technical Secretariat shall set up an independent third-party panel composed of a minimum of three members (i.e., a chair and two members) for the PEFCR review. The panel should comprise of at least one LCA experts (preferably with a background on the product category under consideration and product-related environmental aspects), one representative from NGOs, and one industry expert. One member shall be selected as the chair. The panel members shall not have conflicts of interests on branded products and cannot be members of the Technical Secretariat.

The review panel of this PEFCR consists of the following members:

[This section will be completed at a later date]

3.2 REVIEW REQUIREMENTS FOR THE PEFCR DOCUMENT

The reviewers shall investigate whether the PEFCR has been developed in accordance with the requirement provided in this Guidance and supports creation of credible and consistent PEF profiles. In addition, the following criteria shall also apply:

- The PEFCR is consistent with the guidelines provided in the PEF Guide
- Unit of analysis, allocation and calculation rules are adequate for the product category under consideration
- Selected LCIA indicators and additional environmental information are appropriate for the product category under consideration and the selection is done in accordance with the guidelines stated in this Guidance and the PEF Guide
- Both LCA-based data and the additional environmental information prescribed by the PEFCR give a description of the significant environmental aspects associated with the product

3.3 REASONING FOR DEVELOPMENT OF PEFCR

These PEFCR were developed with the aim of evaluating the environmental impacts of dry pasta and of making possible comparisons between different products belonging to the same product category. These PEFCR were developed according to the *Product Environmental Footprint (PEF) Guide* and to the *Guidance for the implementation of the EU Product Environmental Footprint (PEF) during the Environmental Footprint (EF) pilot phase v. 4.0*.

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286 3.4 CONFORMANCE WITH THE PEFCR GUIDANCE

287 [Summarize the conformity assessment against the 'Guidance for the Implementation of the EU PEF
288 during the Environmental Footprint (EF) pilot phase'].

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4. PEFCR SCOPE

The product category for this PEFCR is **dry pasta**, which is defined as follows:

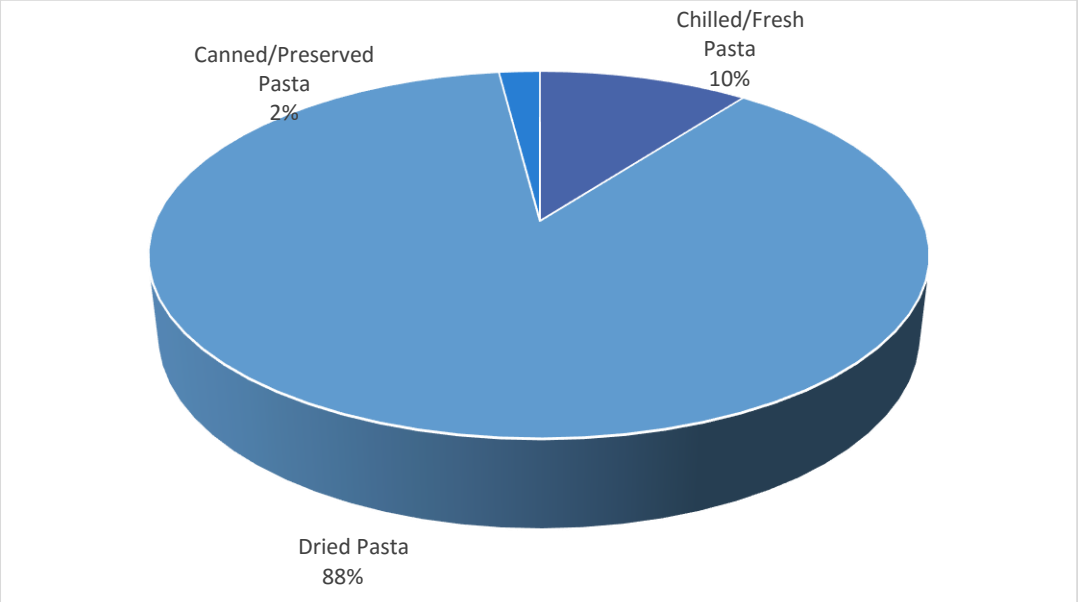
Dry pasta is pasta whose humidity content do not generally exceed 13% on dry solids. Pasta is any kind of shaped product obtained by extruding or forming a dough prepared with durum wheat semolina/flour or whole durum wheat semolina/flour, and water and/or eggs. Other cereal flours can be used; other ingredients (such as vegetables or spices) may be added to the dough.

The above definition has been provided to the European Commission and has been endorsed as pasta descriptor in the frame of the food additives categorization system as per EU Reg. 1333/2008.

Pasta is a carbohydrates based food generally served with sauces or other seasonings, which are not however included in the scope of this study.

Fresh pasta, filled pasta and pre-cooked pasta are out of the scope of this PEFCR. The TS decided not to include these typologies of pasta in the scope of the PEFCR because they have different characteristics (ingredients, production technologies, storage, shelf life) and, due to an high market fragmentation, it was considered extremely difficult to reach an adequate representativeness among the relative stakeholders in the PEFCR development process. However these typologies of pasta represent a limited percentage of the total European pasta market (Figure 4) and their inclusion in the scope of these PEFCR can in case be taken into consideration in a future revision.

Figure 4 - European pasta market in 2014 (Source: Euromonitor)



The full life cycle (cradle to grave) of pasta sold on the EU-28 market is included in the scope of this PEFCR.

4.1 UNIT OF ANALYSIS

Key aspects regarding "What?", "How much?", "How long?" and "How well?" are used to define the function provided by pasta products and thus to determine the unit of analysis

***What**: dry pasta, packaged, bought at the retail and cooked for the time suggested by the producer.*

***How much**: 1 kg of dry pasta. The weight of the packaging is not included in the 1 kg but in scope of the analysis.*[4]

***How long**: available for consumption before the expiry date. The average shelf life of pasta is commonly between 24 and 36 months.*

***How well**: the product shall fulfil the legal quality requirements for selling at retail.*

4.2 REPRESENTATIVE PRODUCT

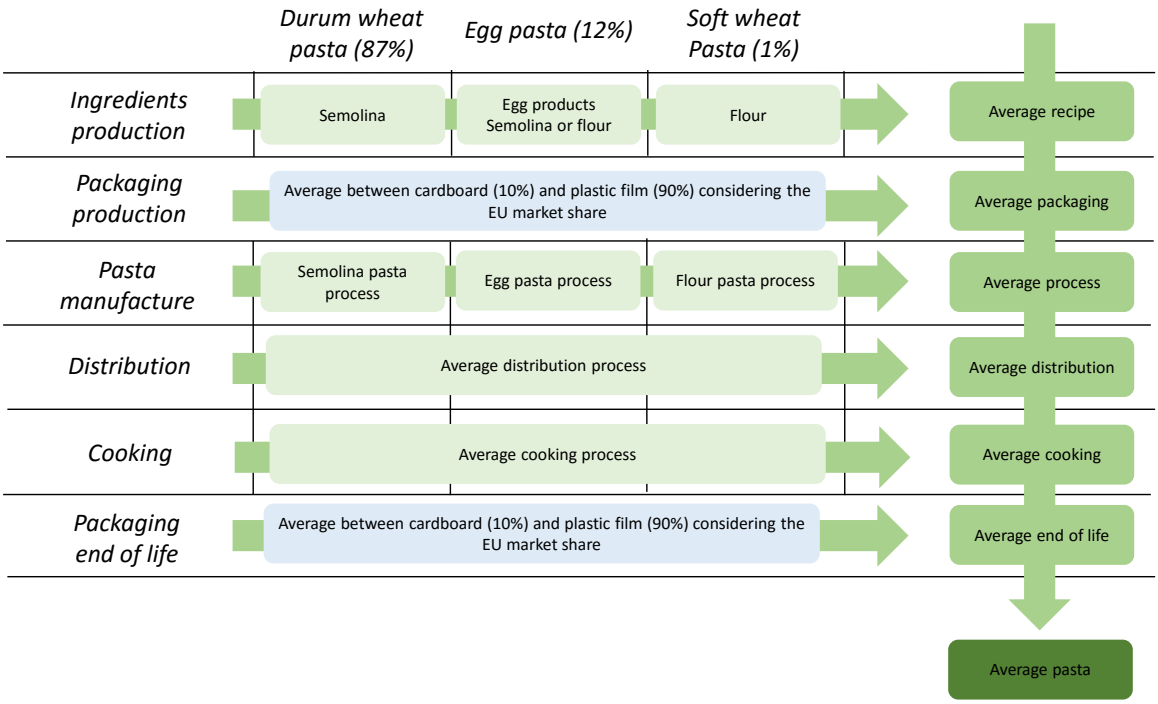
The representative product is a single virtual product based on:

- the main typologies of dry pasta sold in the EU market (Source: AIDEPI, IRI, ACNielsen).
- the pasta packaging mix in the EU market (Source: manufacturers members of the Technical Secretariat).

A scheme of the representative product is reported in Figure 5.

Figure 5 – Representative product

[4] The TS explored the possibility to use portion size as a basis for the functional unit. In this regard he UNAFPA Circular letter no. 136 of 22 March 2010 "Portion sizes: agreement on the UN.A.F.P.A. rationale on portion size" is reported below. In order to provide an harmonized nutrition information to the consumers based on a per portion basis, UNAFPA (Union of Organizations of manufacturers of Pasta Products of the European Union) has reached an agreement for pasta portions across Europe on the following ranges: uncooked pasta: 80-100g; cooked pasta: 180-220g. There is a worldwide consensus among high-level nutrition scientists that carbohydrates are a key ingredient in the eating patterns. Pasta is a carbohydrates based food which is generally eaten with other foods that serve as partners on the plate or in a bowl. A pasta meal provides a wide range of nutrients and it is therefore considered a main meal. Worldwide, scientists and government agencies (see, amongst others, the EFSA Opinion adopted on 13 March 2009 in "The EFSA Journal" (2009) 1008, 1-14) recommend a reference intake of carbohydrates of around 55% for a 2000 kcal diet. On the basis of a daily average standard diet of 2000 kcals, taking into account that the 35% of the daily intake (about 700 kcals) is provided by the lunch/dinner meal [as indicated by the LARN (Recommended Daily Intakes for Energy and Nutrients) of the "Società Italiana della Nutrizione Umana"(Italian Society of the Human Nutrition)], the 55% of which from carbohydrates, we achieve the above indicated 80/100g of pasta portions which, as main dish and principal source of carbohydrates, covers (with a tomato dressing or other light dressings) around 400/450 kcals. However, due to the fact that 1 kg is a unit easier to use and it is also the one used in the PCR of other systems , the TS concluded that using weight was the most consensual and reliable way to proceed.



The reference flow of 1 kg refers to dry pasta. The weight of packaging is not included in the 1 kg but in the scope of the analysis.

For further information about the representative product see Annex 1.

4.3 PRODUCT CLASSIFICATION (NACE/CPA)

Dry pasta falls into the NACE category 10.73 Manufacture of macaroni, noodles, couscous and similar farinaceous products.

4.4 SYSTEM BOUNDARIES – LIFE-CYCLE STAGES AND PROCESSES

The life cycle stages included in the system boundaries are:

- ingredients production;
- packaging manufacturing;
- pasta manufacturing;
- distribution;
- cooking;
- end of life of packaging.

The main ingredient of pasta are semolina produced by milling durum wheat or flour produced by milling soft wheat. Other cereals can be used in some countries.

The cultivation of cereals is included in the system boundaries. The term cultivation refers to all the operations between soil tillage and harvest. During this period, several inputs are used (seeds, fertilizers, pesticides, diesel for machinery, etc.) and emissions to air (NH_3, N_2O, etc.) and water (nitrates, phosphorus, etc.) occur.

Cereals are then carried to the mill where semolina (for durum wheat) and flour (for the other cereals) are produced starting from the kernels with a series of mechanical treatments.

For egg pasta eggs are the other main ingredient. The system boundaries include all the inputs (pullets, feed, electricity, water, etc.) and the outputs (air and water emissions, poultry manure, etc.) of eggs production.

For the production of egg pasta or egg products can be used. Egg products are preparations obtained by a heat treatment starting from fresh eggs. If applicable this process shall be included in the system boundaries.

If other ingredients (vegetables, spices, etc.) are used for the production of pasta, their production shall be included in the system boundaries.

The ingredients are then carried to the plant where pasta production occurs. Here the ingredients are kneaded with water to form a dough. This dough is then compressed by an extruder and passes through the “screw”, through the filter and into the die, to take its definitive shape of pasta. The product leaves the die with a humidity of more than 30% and it is sent to the drying process. Once the drying process is finished, the humidity level must be lowered to below the value established by law (about 13%, depending on the national laws). Pasta is then packaged and sent to the distribution. All the inputs (energy, water, etc.) and outputs of this phase are included in the system boundaries

Dry pasta does not require a cold storage, neither at the point of sale, nor at consumer’s home.

Regarding the preparation there is basically only one way and it is by cooking it in boiling salted water.

Packaging has to be disposed after use. This phase depend on the behaviour of the consumer and on the availability of proper waste management chains.

In all the stages will be considered by-products or co-products all the products generated by a process that have an economic value. The list of processes with the related by/co-coproduct is reported in Figure 6.

Figure 6 - By-products/co-products considered in the different processes

Process	Main product	By-products/ co-products
Cereals cultivation	Grain	Straw
Eggs production	Eggs	Hens for slaughter
Milling	Semolina/Flour	Bran, germ, middlings
Pasta production	Pasta	Pasta scraps

Figure 7 presents the system diagram indicating the processes that are included in the product system.

397 Figure 7 - Processes included in the product system

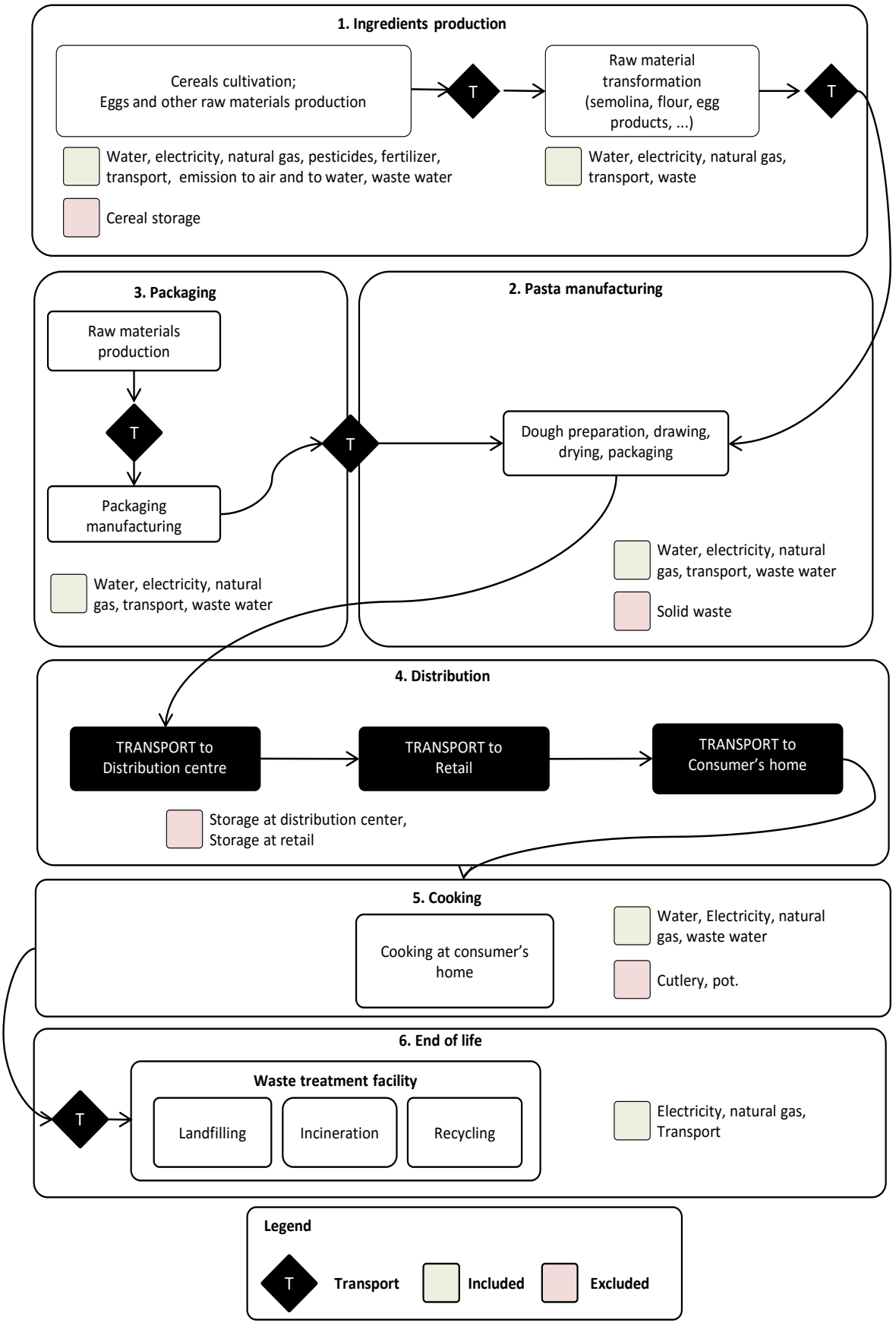


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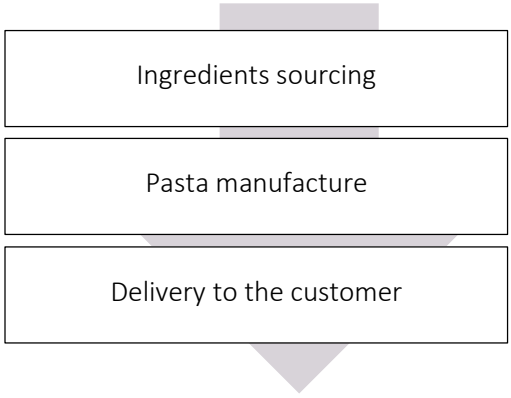
Figure 8 are listed the activities that are managed directly by the organizations. Delivery is not always, or not always entirely, under the control of the organizations.

Figure 8 – Activities under the control of the organizations



UPSTREAM PROCESSES/SCENARIOS

Ingredients production

This stage includes:

- The cultivation of cereals
- The production of semolina and/or flour (from cereals)
- The production of eggs (for egg pasta)
- The production of egg products(for egg pasta)
- The production of other ingredients
- The transportation of ingredients to the processing plant

Packaging manufacturing

This stage includes:

- Packaging raw materials production
- The transportation of packaging raw materials to the processing plant
- Packaging manufacturing

DOWNSTREAM PROCESSES/SCENARIOS

Distribution

In this stage are included:

- The transport from the pasta production plant to the distribution centre;
- The transport from the distribution centre to the retailer;

- The transport from the distribution centre to the retailer and to the final consumer.

Cooking

In this stage are included water and energy consumption related to cooking.

Dressing is not included in the system boundaries.

End of life of packaging

In this stage the end of life of packaging is included.

End-of-life of packaging is considered in accordance with packaging waste management statistics from Eurostat[5] relative to the countries where the product is consumed.

EXCLUSIONS

The processes listed in Table 1 were excluded from the system based on the experience of companies involved in the Technical Secretariat of the pilot for dry pasta.

Table 1 – Processes excluded from the screening study

Life cycle stage	Exclusions	Justification
Ingredients production	Cereal storage	Cereals may be stored before being transported to the mill. Energy and products used in this phase are considered negligible
Pasta manufacture	Capital goods	Considering the long life of buildings and machineries and the huge amount of pasta produced during this period, the production of machineries and buildings is considered negligible
Distribution	Capital goods at distribution centre and at retail	These are allocated to numerous products. It is common practice in LCA not to include capital goods from the background systems, when not already included in secondary data.

[5] http://ec.europa.eu/eurostat/statistics-explained/images/0/09/Waste_statistics_YB2014_upd.xlsx

4.5 SELECTION OF THE EF IMPACT CATEGORIES INDICATORS

The environmental impacts were evaluated considering the default impact categories and the relative impact assessment models recommended in the *Product Environmetnal Footprint guide* and reported in Figure 9.

Figure 9 – Impact categories recommended

Impact category	Model	Unit	Source
Climate change	Bern model – Global Warming potentials (GWP) over a 100 year time horizon	kg CO_2-eq	Intergovernmental Panel on Climate Change, 2007
Ozone depletion	EDIP model based on the ODPs of the WMO over an infinite time horizon	kg CFC---11 eq	WMO, 1999
Freshwater ecotoxicity	USETox model	CTUe	Rosenbaum et al., 2008
Human toxicity – cancer Effects	USETox model	CTUh	Rosenbaum et al., 2008
Human toxicity – non cancer effects	USETox model	CTUh	Rosenbaum et al., 2008
Particulate matter	RiskPoll model	kg PM2.5-eq	Humbert, 2009
Ionising radiation	Human Health effect model	kg U_{235}-eq	Dreicer et al., 1995
Photochemical ozone formation	LOTOS – EUROS model	kg NMVOC-eq	Van Zelm et al., 2008
Acidification	Accumulated Exceedance model	mol H+ eq	Seppala et al.,2006; Posch et al., 2008
Terrestrial eutrophication	Accumulated Exceedance model	mol N eq	Seppala et al.,2006; Posch et al., 2008
Freshwater eutrophication	EUTREND model	kg P eq	Struijs et al., 2009
Marine eutrophication	EUTREND model	kg N eq	Struijs et al., 2009
Land use	Soil Organic matter (SOM) model	kg C deficit	Mila i Canals et al., 2007
Water resource depletion	Swiss Ecoscarcity model	m_3 water eq	Frischknecht et al., 2008
Mineral, fossil, & renewable resource depletion	CML 2002 model	kg Sb eq	Van Oers et al., 2002

As agreed by the Technical Advisory Board (TAB) the identification of the most relevant impact categories and life cycle stages should be based on the normalised and weighted results of the screening study. However, considering some current limitations related to normalisation factors and the equal weighting system, the pilots have the option of identifying the most relevant impact categories and life cycle stages according to the procedure below.

Starting from the normalised and weighted screening results, each Technical Secretariat was asked to select the impact categories that they consider more relevant in terms of "communication purposes".

The TS individuated the following impact categories as most relevant for dry pasta:

- Land Use
- Climate change
- Freshwater Ecotoxicity
- Water Resource depletion
- Acidification
- Marine eutrophication
- Freshwater Eutrophication

The rationale for the selection of these impact categories is provided in Table 2.

Table 2 – Rationale for selecting most relevant impact categories for dry pasta

Impact category	Rationale
Land Use	Land use is a relevant aspect in all the food chains, because it is strictly correlated with key issues such as biodiversity, land management and competition with other chains.
Climate Change	Climate change is one of the most known and reliable impact category and it can't be neglected when assessing the environmental performances of any product.
Freshwater Ecotoxicity	Freshwater ecotoxicity, due mainly to the use of chemicals and fertilizers in agriculture, is a key issue when cultivation activities are relevant in a supply chain, as in the case of dry pasta.
Water resource depletion	Use of water resources is a key issue when agricultural activities are included in the system boundary of a product, as in the case of dry pasta.
Acidification	Cultivation of cereals is a fundamental stage of pasta supply chain. Use of N fertilizers in agriculture is a recognized cause for acidification.
Marine eutrophication	Cultivation of cereals is a fundamental stage of pasta supply chain. Use of N and P fertilizers in agriculture is a recognized cause for marine eutrophication.
Freshwater eutrophication	Cultivation of cereals is a fundamental stage of pasta supply chain. Use of N and P fertilizers in agriculture is a recognized cause for freshwater eutrophication.

4.6 ADDITIONAL ENVIRONMENTAL INFORMATION

According to the Product Environmental Footprint (PEF) guide, additional information may include:

- Bill-of-materials data;
- Disassemblability, recyclability, recoverability, reusability information, resource efficiency;
- Information on the use of hazardous substances;
- Information on the disposal of hazardous/non-hazardous waste
- Information on energy consumption;
- Information on local/site-speciic impacts; e.g. local impacts on acidification, eutrophication and biodiversity;
- Other relevant environmental information on the activities and/or sites involved, as well as on the product output.

4.7 ASSUMPTIONS/LIMITATIONS

The main limitation when assessing the environmental footprint of dry pasta is the lack of information about the production of ingredients. Pasta manufactory companies often buy semolina, flour, egg product and the other ingredients from suppliers, without having control or influence on the agricultural raw materials production and sourcing. Only a few big companies have mills owned. Suppliers buy cereals and other raw materials on the market, usually from traders or cooperatives, and therefore there is often no possibility for pasta manufacturers to have primary data about the agricultural production with a reasonable effort. The assumptions to be used to overcome this limitation are detailed in section 5.3.

5. RESOURCE USE AND EMISSION PROFILE

5.1 SCREENING STEP

The outcomes of the screening study are reported in brief below and in detail in the Screening Report.

In the context of PEF/OEF pilot phase we can define a hotspot as all life cycle stages, all processes and all elementary flows individually contributing at least 40% to any impact category before normalisation and weighting.

According to this definition, the environmental hotspots individuated for dry pasta are those reported in Table 3.

Table 3 - Environmental hotspots individuated

Life Cycle Stages	Processes	Elementary flows
Ingredients production Packaging production Cooking	Cereals cultivation Packaging production Cooking	Carbon dioxide in air (Cooking) Phosphate and phosphorus in water (Cereals cultivation) Nitrate in water (Cereals cultivation) Transformation, to arable (Cereals cultivation) Water, turbine use (Packaging production)

The most relevant life cycle stages[6] for dry pasta are:

- Ingredients production
- Pasta production
- Packaging production
- Distribution
- Cooking

The most relevant processes[7] for dry pasta are:

- Cereals cultivation
- Eggs production
- Pasta production
- Packaging production
- Transport to the distribution centre
- Cooking

The most relevant elementary flows[8] for the most relevant impact categories are reported in Table 4.

[6] In the context of the PEF screening all the life cycle stages which together contribute over 80% (before normalisation and weighting) to any of the baseline impact shall be considered as relevant. This should start from the largest to the smallest contributions.

[7] In the context of the PEF screening phase processes shall be defined as relevant where they collectively contribute at least 80% to any impact category before normalisation and weighting.

[8] All elementary flows contributing cumulatively more than 80% to each impact category shall be considered as relevant. No elementary flow contributing more than 5% to the impact category can be considered as not relevant.

538 Table 4 - Most relevant elementary flows

Impact category	Most relevant elementary flows	Process
Land Use	Transformation, to arable (raw material) and Transformation, to arable, non-irrigated, intensive (raw material)	Cereals cultivation
Climate change	Dinitrogen monoxide (air) and carbon dioxide to air (air)	Cereals cultivation
	Carbon dioxide (air)	Pasta production
	Carbon dioxide (air)	Cooking
Freshwater Ecotoxicity	For this impact category there is a high fragmentation. The 80% of the impact is reached with 34 elementary flows and none of them gives a contribution of more than 10%.	
Water Resource depletion	Water, turbine use (raw material), Water, cooling (raw material), Water, well, in ground (raw material), Water, river (raw material)	Cereals cultivation
	Water, turbine use, Water, cooling	Packaging production
Acidification	Sulfur dioxide (air), Nitrogen oxides (air), Ammonia (air)	Cultivation
	Sulfur dioxide (air)	Pasta production
	Sulfur dioxide (air), Nitrogen monoxide (air)	Cooking
Marine eutrophication	Nitrate (water), Nitrogen oxides (air)	Cereals cultivation
Freshwater Eutrophication	Phosphate (water), Phosphorus (water)	Cereals cultivation

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540

541 ## 5.2 DATA QUALITY REQUIREMENTS

542 According to the materiality approach promoted in the PEF the focus in data collection must be driven
543 to the most relevant processes identified and reported in the previous table. The effort of data
544 collection shall be focused on the most relevant life cycle stages and processes identified in the
545 screening. Some of these processes belong to the foreground system while the others belong to the
546 background system.

547

548 Table 5 –Data requirements for the different life cycle stages

Life cycle stage	Foreground/Background	Relevant/Non relevant stage
Ingredients production	Background/Foreground	Relevant
Packaging production	Background	Relevant
Pasta production	Foreground	Relevant
Distribution	Foreground/Background	Relevant
Cooking	Background	Relevant
End of life of packaging	Background	Non relevant

549

550

Data can be classified as specific, semi-specific or generic data, according to the definitions reported below.

Specific data *refers to directly measured or collected data representative of activities at a specific facility or set of facilities. It is synonymous of primary data.*

Generic data *refers to data that is not directly collected, measured, or estimated, but rather sourced from a third-party life cycle inventory database or other source that complies with the data quality requirements of the PEF guide. It is synonymous of secondary data.*

Semi-specific data *are data for which default values are proposed but that companies can replace with specific ones if available.*

Ideally primary data should be used for all the relevant stages, but in practice only secondary data may be available for some processes. In principle primary data should at least be collected for the foreground system while secondary data may be used for the background system. The requirements presented in Table 6 shall be followed when performing a PEF study on dry pasta.

Table 6 – Data requirement for the life cycle stages included in the system boundaries

Life cycle stage	Data requirement	
	When company can access to specific data	When company cannot access to specific data
Ingredients production	Primary	Secondary
Packaging production	Primary	Secondary
Pasta production	Primary	.
Distribution	Primary	Secondary
Cooking	Secondary	
End of life of packaging	Secondary	

In Table 7 data quality criteria for the PEF screening are reported. Criteria for completeness, Methodological appropriateness and consistency and parameter uncertainty are those indicated in the PEF guide. Criteria for time representativeness, technological representativeness and geographical representativeness were developed expressly for dry pasta by the TS.

573 Table 7 – Data quality criteria

	Completeness	Methodological appropriateness and consistency	Time related representativeness	Technological representativeness	Geographical representativeness	Parameter Uncertainty
1 - Very good	Very good completeness (≥ 90%)	Full compliance with all requirements of the PEF guide	≤3 years old data	Specific process and technology	Data from the area under study	Very low uncertainty (≤10%)
2 – Good	Good completeness (80% to 90%)	Attributional process based approach and following three method requirements of PEF guide met: dealing with multi-functionality end-of-life modelling system boundary	3 – 5 years old data	Same process but slightly different technology	Data from an area smaller/bigger than that under study (e.g. region/continent instead of country)	Low uncertainty (10% to 20%)
3 – Fair	Fair completeness (70% to 80%)	Attributional process based approach and two of the following method requirements of PEF guide met: dealing with multi-functionality, end-of-life modelling system boundary	5 - 10 years old data	Same process but significantly different technology	Data from an area where technology is similar to that of the area under study	Fair uncertainty (20% to 30%)
4 - Poor	Poor completeness (50% to 70%)	Attributional process based approach and one of the following method requirements of PEF guide met: dealing with multi-functionality, end-of-life modelling system boundary	10 - 15 years old data	Similar process	Global data	High Uncertainty (30% to 50%)
5- Very poor	Very poor or unknown completeness (≤50%)	Attributional process based approach but none of the following method requirements of the PEF Guide met: dealing with multi-functionality, end-of-life modelling system boundary	> 15 years old data	Other or unknown	Unknown/Data from an area where technology is different to that of the area under study	Very high uncertainty (>50%)

According to the PEF Guide *the overall data* quality shall be calculated by summing up the achieved quality rating for each of the quality criteria, divided by the total number of criteria (i.e. six). The Data Quality Rating (DQR) result is used to identify the corresponding quality level in Table 8. A PEF study shall fulfil the quality requirements reported in Table 9.

$$DQR = \frac{TeR + GR + TiR + C + P + M}{6}$$

DQR: Data quality rating of the dataset

TeR: Technological Representativeness

GR: Geographical representativeness

TiR: Time-related Representativeness

C: Completeness

P: Precision/Uncertainty

M: Methodological Appropriateness and Consistency

Table 8 - Overall data quality level according to the achieved data quality rating

Overall data quality rating (DQR)	Overall data quality level
≤ 1.6	Excellent quality
1.6 to 2.0	Very good quality
2.0 to 3.0	Good quality
3.0 to 4.0	Fair quality
> 4	Poor quality

Table 9 - Requirements and the assessment of data quality according to the PEF guide

Description	Minimum data quality required	Type of required data quality assessment
Data covering at least 70% of contributions to each EF impact category	Overall "Good" data quality (DQR ≤ 3.0)	Semi-quantitative based on Table 7
Data accounting for 20-30% of contributions to each EF impact category	Overall "Fair" data quality	Qualitative expert judgement (Table 7 can be used to support the expert judgement). No quantification is required.
Data used for approximation and filling identified gaps (no more than 10% of the contribution to each EF impact category)	Best available data	Qualitative expert judgement (Table 7 can be used to support the expert judgement).

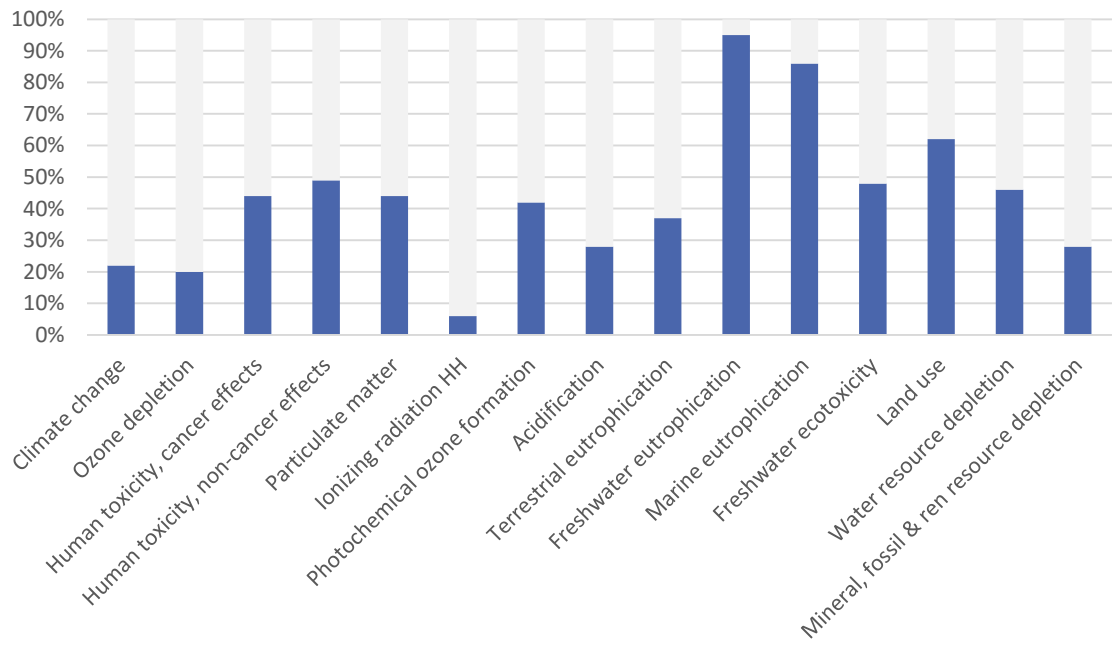
5.3 REQUIREMENTS REGARDING FOREGROUND SPECIFIC DATA COLLECTION

CEREALS CULTIVATION

Cereals cultivation is a relevant process for all the impact categories.

Good data quality (DQR ≤3.0) is mandatory for this process.

Figure 10 – Contribution of cereals cultivation in the impact categories for which it is relevant



The following hierarchy shall be considered when collecting data about cereals cultivation:

1. Specific data shall be collected and used whenever they are available or can be collected with a reasonable cost and effort (i.e. when the commissioner of PEF study has access to cereals suppliers).
2. If specific data for cereals cultivation is not available, generic datasets can be used (see Table 28 and Table 29) if a DQR ≤3.0 can be achieved (e.g. datasets referring to the specifying countries).
3. If there are no generic datasets available (i.e. a DQR ≤3.0 cannot be achieved with the existing ones) starting from a secondary dataset, remodel/adapt it to the specific situation (including at least yield, fertilizers use and fertilizers-related emissions) achieving a DQR ≤3.0 (see *Annex VII: Background data* for an example).

Table 10 – DQR guidance for cereals cultivation

	Time related representativeness	Technological representativeness	Geographical representativeness
1 - Very good	≤3 years old data	Average of the typology of cultivation (e.g. conventional, organic) in the specific country	Data from the country under study
2 – Good	3 – 5 years old data	Average of the typology of cultivation (e.g. conventional, organic) in an area smaller/bigger than that under study	Data from an area smaller/bigger than that under study (e.g. region/continent instead of country)
3 – Fair	5 - 10 years old data	Average of the typology of cultivation (e.g. conventional, organic) in a country similar to that of the area under study	Data from an area where technology is similar to that of the area under study
4 - Poor	10 - 15 years old data	Average of a different typology of cultivation in the specific country	Global data
5- Very poor	> 15 years old data	Other or unknown	Unknown/Data from an area where technology is different to that of the area under study

Specific data for cereals cultivation

If specific data can be collected a representative sample of farms in the supply chain should be defined: data from farms that together deliver at least the 20% of the mass of cereals used shall be collected for each country from which cereals are sourced;

All data shall be collected referring at least to a crop year. The crop year is the period that starts after the harvest of the previous crop and lasts with the harvest of the reference crop. Average data collected over 4 or more consecutive years are preferable, if available.

Activity data reported in Table 11 shall at least be collected from each farm of the sample.

640 Table 11 – Specific activity data required for cereal cultivation

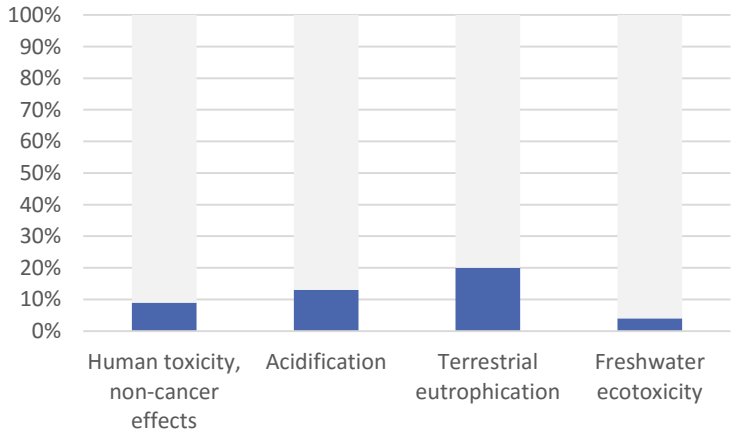
	Data to be collected	Unit
Input parameters	Mass of seeds	kg/ha
	Mass and type of fertilizers	kg/ha
	Mass and type of pesticides	kg/ha
	Volume of water used for irrigation	m^3/ha
	Volume of diesel (or other fuel) used	l/ha
Output parameters	Cereal production (yield)	kg/ha
	Price of cereal	€/t
	Straw production	kg/ha
	Price of straw (if it is sold)	€/t
	Data to be calculated	**Unit**
Calculated parameters	CO_2 emissions from fertilizers application (calculated)	kg/ha
	N_2O emissions from fertilizers application (calculated)	kg/ha
	NH_3 emissions from fertilizers application (calculated)	kg/ha
	NO_X emissions from fertilizers application (calculated)	kg/ha
	Nitrates emissions from fertilizers application (calculated)	kg/ha
	Phosphorus and phosphate emissions from fertilizers application (calculated)	kg/ha
	Emissions from pesticides (calculated)	kg/ha
	Emissions of heavy metals	kg/ha

641

642 ## EGGS PRODUCTION

643 Eggs production is a relevant process for eggs pasta (Figure 11).

644 Figure 11 - Contribution of cereals cultivation in the impact categories for which it is relevant



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647 Specific data shall be therefore collected and used whenever they are available or can be collected
648 with a reasonable cost and effort (i.e. when the commissioner of PEF study has access to eggs
649 suppliers).

650 All data shall be collected referring at least to a year.

Table 12 – Specific data required for eggs production

	Item	Information	Unit
Input	Feed	Mass and typology	kg/y
	Cleaning agents	Mass and type of cleaning agent	kg/y
	Energy	Amount and type of fuel (natural gas, fuel oil, diesel, etc.) for heat and electricity use (from grid, produced on-site) for all activities at the plant.	MJ/y
	Water	Volume of water used	m^3/y
Output	Products	Mass of all the products of the plant	kg/y
	Co-products	Mass and destination of all the co-products of the plant	kg/y
	Manure	Volume and destination of manure	m^3/y

If specific data for eggs production are not available, generic data can be used. The dataset Consumption eggs, laying hens > 17 weeks, at farm/NL mass from the Agri-Footprint database can be used in this case.

CEREALS MILLING

Cereals milling is not a relevant process, but in some case can be a foreground process. Specific data shall be used to model cereals milling if available (i.e. when the commissioner of PEF study has access to mill). At least data reported in Table 13 shall be collected for every mill.

Table 13 – Specific data required for cereals milling

	Item	Information	Unit
Input	Ingredients	Mass	kg/y
	Energy	Amount and type of fuel (natural gas, fuel oil, diesel, etc.) for heat and electricity use (from grid, produced on-site) for all activities at the plant.	MJ/y
	Water	Volume of water used	m^3/y
Output	Products	Mass of all the products of the plant	kg/y
	Co-products	Mass and destination of all the co-products of the plant	kg/y

In the cases where specific data for cereals milling are not available, datasets from the Agri-footpirnt database can be used.

EGGS PASTEURIZATION

Specific data shall be used to model eggs pasteurization process. At least data reported in Table 14 shall be collected for every plant involved in the manufactory of the analysed product.

673 Table 14 – Specific data required for eggs pasteurization

	Item	Information	Unit
Input	Ingredients	Mass	kg/y
	Energy	Amount and type of fuel (natural gas, fuel oil, diesel, etc.) for heat and electricity use (from grid, produced on-site) for all activities at the plant.	MJ/y
	Water	Volume of water used	m^3/y
Output	Products	Mass of all the products of the plant	kg/y
	Co-products	Mass and destination of all the co-products of the plant	kg/y

674

675 *In the cases where specific data for eggs pasteurization are not available, since there are not available datasets,*
676 *semi-specific data reported in Table 15 can be used. These data refers to a sample of Italian plants.*

677

678 Table 15 - Semi-specific data for eggs pasteurization

Products		
Pasteurized eggs	1	kg
Materials/fuels		
Eggs	1.2	kg
Water	2,1	kg
Electricity/heat		
Electricity	0,25	MJ
Heat	0,41	MJ

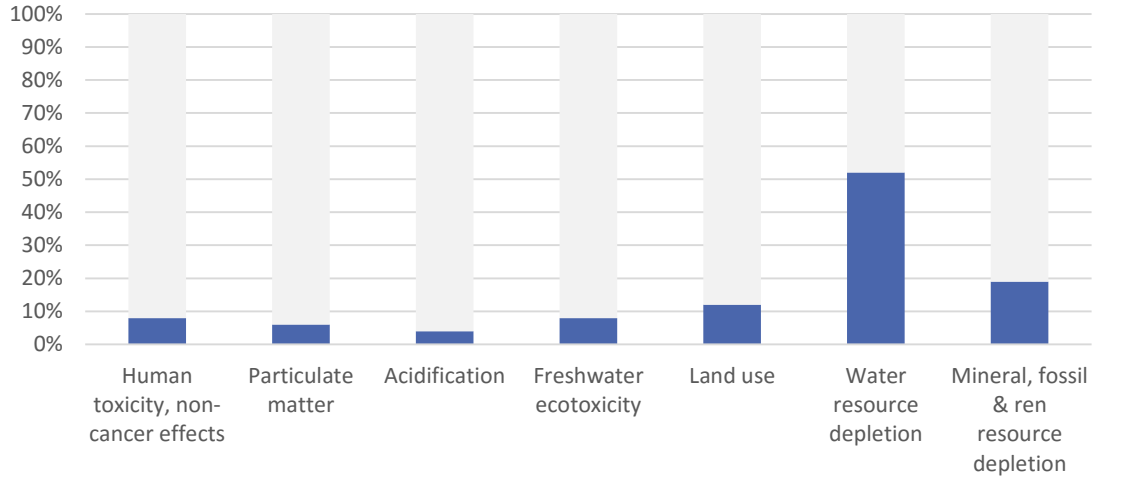
679

680 ## PACKAGING MANUFACTURING

681 Packaging manufacturing is a relevant process for 7 impact categories (Figure 12).

682

683 Figure 12 - Contribution of packaging manufacturing in the impact categories for which it is relevant



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The model of primary packaging material production should be based on specific activity data. Not the full life cycle of packaging material production is required on specific activity data but only the direct packaging supplier to the pasta manufactory.

Activity data per main primary packaging material are listed in Table 16. Activity data shall be gathered over a period of 12 months.

Table 16 – Specific activity data required for packaging

Item	Information required
Bill of materials	Mass of every material used for the production of the packaging, including recycled content
Capacity	Volume or mass of product in each packaging unit
Energy	Amount and types of fuel for heat and electricity used for manufacturing the packaging
Water	Volume or water used for manufacturing the packaging
Transport	Transport mode and distance from packaging manufacturing plant

If specific data for packaging manufacturing is not available, the best available secondary data shall be used. It is suggested to use the eco-profiles released by Plastics Europe[9] for plastic packaging and the datasets from the Ecoinvent database for the other typologies of packaging.

A Crosscutting Working Packaging Working Group (PWG) is currently working to provide guidance on packaging related modelling and data issues in the running Environmental Footprint pilot phase. In particular, the WG will propose requirements to be implemented in the final PEFCRs/OEFSRs and, to the extent possible, to be tested by the pilots in the supporting studies. It will ensure material neutrality in all activities of PWG and avoid discrimination of packaging materials or systems.

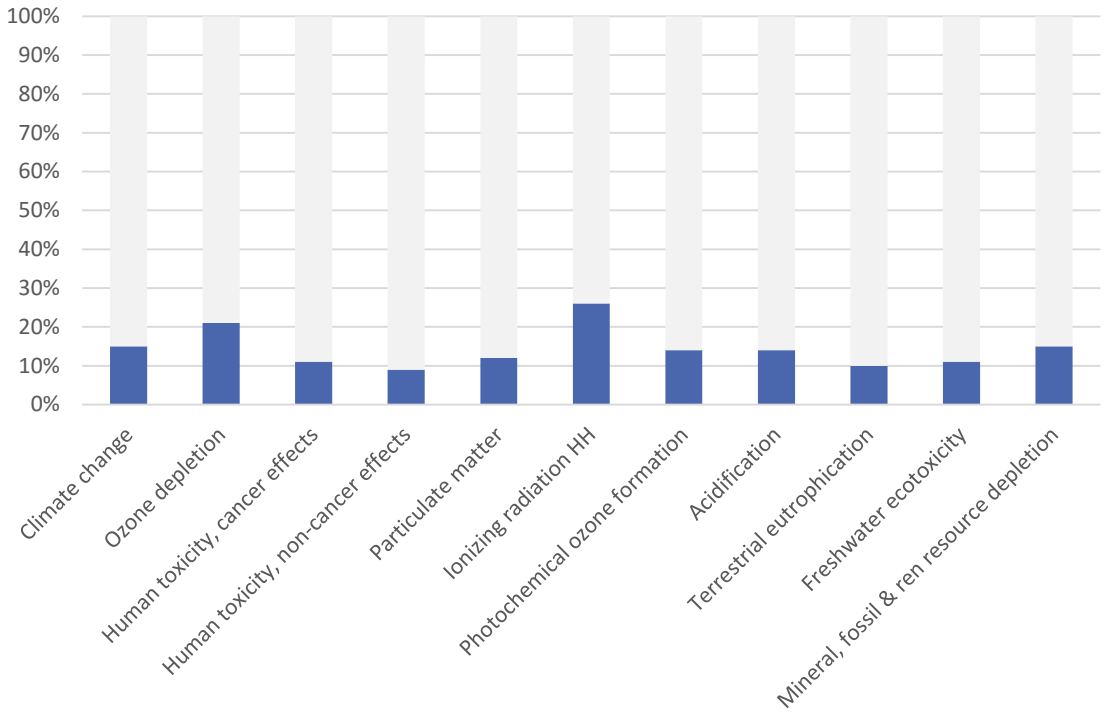
In the final PEFCR the section of packaging manufacturing will be based on the recommendations of the PWG.

PASTA MANUFACTURING

Pasta manufacturing is a relevant process for 11 impact categories (Figure 13).

[9] www.plasticseurope.org

Figure 13 - Contribution of pasta manufacturing in the impact categories for which it is relevant



Specific data shall be used to model pasta manufacturing process. At least data reported in Table 17 shall be collected for every plant involved in the manufactory of the analysed product. If available data referring to the production lines used for the analysed product are preferable to data referring to the whole production of the plant. Activity data shall be gathered over a period of 12 months.

Table 17 – Specific data required for pasta manufacturing

	Item	Information
Input	Ingredients	Mass
	Cleaning agents	Mass and type of cleaning agent
	Energy	• Amount and type of fuel (natural gas, fuel oil, diesel, etc.) for heat • Amount of electricity use (from grid, produced on-site) and supplier specific mix (if available)
	Water	Volume of water used
Output	Products	Mass of all the products of the plant
	Co-products	Mass and destination of all the co-products of the plant
	Waste water	Volume and COD content of wastewater released to treatment

LOGISTICS

Specific data should be collected at least from the transport between the pasta manufacturer and the distribution centre. Specific data to be collected is the average distance for which the product is transported. When primary data on logistics are not available, the default data reported in Table 18 shall be used. The source of this data is the document "PEF / OEF : Default data to be used to model

distribution, storage and use stage, version March 1ST, 2015" prepared in the context of the PEF pilots.

Table 18 – Default data for logistics

Parameter	Transport modality	Default value	Unit
Transport of raw materials to processing plants (e.g. cereals from farm to mill, eggs from farm to processing plant, flour/semolina from mill to pasta manufacturing plant)	Truck (16-32 t, EURO 4)	300	kg*km
Other products (such as packaging) from supplier to manufacturing plant	Truck (16-32 t, EURO 4)	1500	kg*km
Transport of the final product from the manufacturing plant to the distribution centre	Truck (7.5-16 t, EURO 4)	1500	kg*km
Transport from the distribution centre to the point of sale	Truck (7.5-16 t, EURO 4)	300	kg*km
Transport from the point of sale to consumer's home	Car	0.38	km

USE STAGE - COOKING

The European Commission gives guidance and requirements for taking into account the use stage results when developing and implementing a PEFCR in the issue paper *Guidance and requirements for handling the use stage in PEFCRs*.

According to this document "the use stage describes how the product is expected to be used by the final consumer. "

Since dry pasta does not require cold storage, only the preparation shall be considered in the use stage when developing a PEF study.

Regarding the preparation of dry pasta there is basically only one way and it is by cooking it in boiling salted water.

A PEFCR can potentially be applied in different contexts and with different goals. Three possible applications are currently described in the PEF guide[10]:

1. in-house use;
2. B2B or B2C green claim without comparisons or comparative assertions;
3. B2B or B2C green claim with comparisons or comparative assertions.

The use stage shall be modelled and reported differently depending on the intended application.

For ***In-house use*** no specific guidance is provided in the present PEFCR.

For ***B2B or B2C green claim without comparisons or comparative assertions:*** the Technical Secretariat developing/revising the PEFCR shall follow the guidelines presented in Table 19. Table 19 outlines

[10] This classification of possible intended uses was included in the PEF Guide only as indicative examples. The final applications of the PEF method will only be decided by the Commission, in consultation with all stakeholders, after the end of the pilot phase.

how to model the use stage processes and how to report its EF results. The actions to be taken are determined by the use stage process dependency, relevancy and uncertainty.

Table 19 - PEFCR guidelines for B2B or B2C green claim without comparisons or comparative assertions.

Is the use stage process			Actions to be taken by the TS	
Product dependent?	Most relevant?	With low uncertainty?	Modelling guidelines	Where to report
Yes	Yes	Yes	To be modelled. Provide default data	In the PEF study results carried out in compliance with the PEFCR, reported separately*
	Yes	No	No modelling	Mandatory additional information: qualitative
	No	Yes	Optional. If modelled, provide default data	Optional additional information: quantitative
	No	No	No modelling	Excluded
No	Yes	Yes	To be modelled. Provide default data	Mandatory additional information: quantitative
	Yes	No	No modelling	Mandatory additional information: qualitative
	No	Yes/No	No modelling	Excluded

*Use stage results shall be reported separately from other life cycle stages but not be added as additional information.

B2B or B2C green claim with comparisons or comparative assertions: the Technical Secretariat developing/revising a PEFCR shall follow the guidelines presented in Table 20. Table 20 outlines how to model the use stage processes and how to report its EF results. The actions to be taken are determined by the use stage process dependency, relevancy and uncertainty.

Table 20 - PEFCR guidelines for B2B or B2C green claim with comparisons or comparative assertions.

Is the use stage process…			Actions to be taken by the TS	
Product dependent?	Most relevant?	With low uncertainty?	Modelling guidelines	Where to report
Yes	Yes	Yes	To be modelled. Provide default data	In the PEF study results carried out in compliance with the PEFCR, reported separately*
	≥ 1 No		No modelling	Excluded
No	Excluded		No modelling	Excluded

For all processes belonging to the use stage (both most relevant and the others) apply the actions listed below:

1) Indicate which use stage processes are product dependent and product independent (as described above).

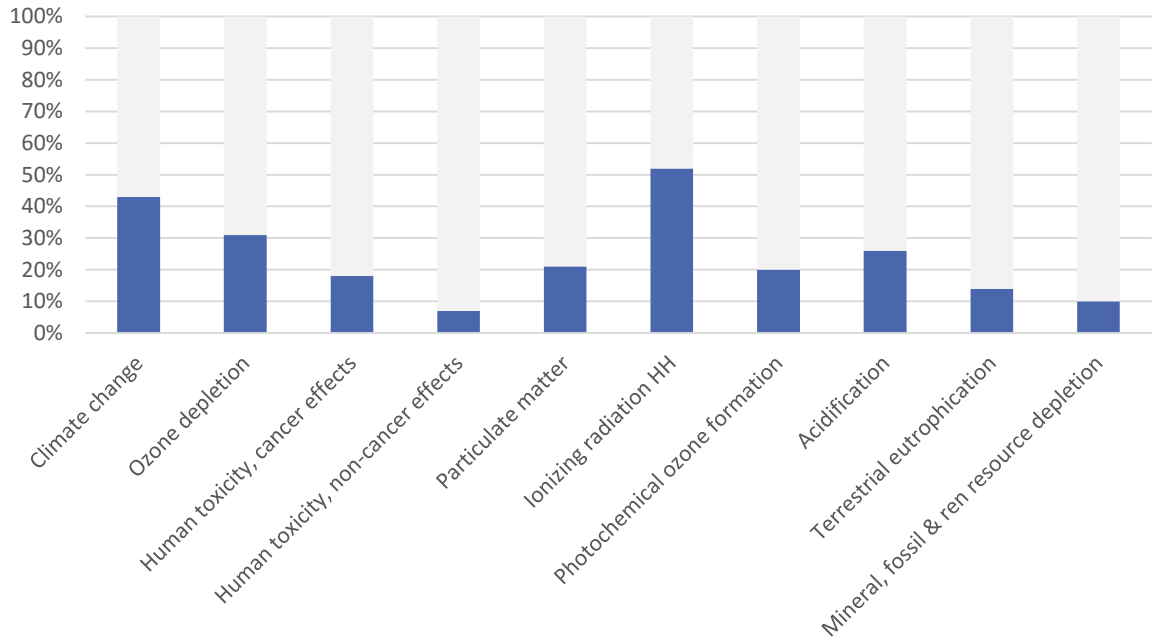
2) Evaluate the level of uncertainty for each use stage process. Guidance to determine the level of uncertainty: all data are considered to have a low uncertainty if (i) they are derived through market research, (ii) they are taken from peer reviewed studies and (iii) they are instructions provided by the producer and directed towards the consumer (through labels, websites or other media). All other data can be considered to have high uncertainty, except when decided otherwise by the TS.

3) Provide default datasets by following the modelling guidelines in Table 1. The default datasets shall reflect as much as possible the reality of market situations.

4) Follow the reporting guidelines for each intended application of the PEFCR.

The screening study highlighted that cooking is relevant for the 10 impact categories reported in Figure 14.

Figure 14 - Contribution of cooking in the impact categories for which it is relevant



In the case of dry pasta cooking is:

- product dependent (cooking time depends on the characteristics of the specific product)
- a relevant process
- with low uncertainty for what concerns the inputs of energy, water and salt[11]

Cooking shall therefore be modelled and results shall be reported separately from those of the other life cycle stages.

The hypothesis to be considered for energy requirements are those reported in the IES PCR in the paragraph 9.1:

[11] Cooking time is usually provided by the producer, the amount of water and salt to be used are standard value for the sector and the energy consumption is derived from the PCR of the International EPD System. These factors are therefore considered with low uncertainty. No reliable data were found about waste water treatment. This process is therefore considered with high uncertainty.

- Boiling phase: 0,18 kWh per kg of water;
- Cooking phase: 0,05 kWh per minute of cooking.

Hobs for cooking pasta can work with gas or electricity. The average European scenario to be considered is 83% gas and 17% electricity. EU average datasets for gas and electricity shall be used for modelling.

Cooking time to be considered is that provided by the producer, usually reported on the pack.

The amount of water to be considered for cooking, in absence of indications provided by the producer, is 1 l every 100 g of pasta.

The amount of salt to be considered for cooking, in absence of indications provided by the producer, is 10 g for litre of water.

Dressing is not included in the system boundaries.

END-OF-LIFE STAGE

The end of life stage includes collection and treatment of waste packaging.

The end of life of packaging shall be modelled according to the formula provided by the European Commission:

$$\left(1-\frac{R_1}{2}\right)\times E_V+\frac{R_1}{2}\times E_{recycled}+\frac{R_2}{2}\times\left(E_{recyclingEoL}-E^*_V\times\frac{Q_S}{Q_P}\right)+R_3\times\left(E_{ER}-LHV\times X_{ER,heat}\times E_{SE,heat}-LHV\times X_{ER,elec}\times E_{SE,elec}\right)+\left(1-\frac{R_2}{2}-R_3\right)E_D-\frac{R_1}{2}\times E^*_D$$

virgin + recycled content | **recyclability** | **recoverability** | **disposal**

R1 [dimensionless] = "recycled (or reused) content of material"

R2 [dimensionless] = "recycling (or reuse) fraction of material"

R3 [dimensionless] = the proportion of material in the product that is used for energy recovery

EV = specific emissions and resources consumed (per unit of analysis) arising from the acquisition and pre-processing of virgin material.

E*V = "specific emissions and resources consumed (per unit of analysis) arising from the acquisition and pre-processing of virgin material assumed to be substituted by recyclable materials:

Erecycled = specific emissions and resources consumed (per unit of analysis) arising from the recycling process of the recycled (or reused) material, including collection, sorting and transportation processes.

ErecyclingEoL = specific emissions and resources consumed (per unit of analysis) arising from the recycling process at the end-of-life stage, including collection, sorting and transportation processes.

ED = specific emissions and resources consumed (per unit of analysis) arising from disposal of waste material at the EoL of the analysed product (e.g. landfilling, incineration, pyrolysis).

E*D =specific emissions and resources consumed (per unit of analysis) arising from disposal of waste material (e.g. landfilling, incineration, pyrolysis) at the EoL of the material where the recycled content is taken from

*If only closed-loop recycling takes place: E*D = ED*

*If only open-loop recycling takes place: E*D = E'D represents the disposal of the material where the recycled content is taken from.*

EER = specific emissions and resources consumed (per unit of analysis) arising from the energy recovery process

ESE,heat = specific emissions and resources consumed (impact per MJ e.g. [kg CO2e/MJ]) that would have arisen from the specific substituted energy source, heat.

ESE,elec= specific emissions and resources consumed (impact per MJ e.g. [kg CO2e/MJ]) that would have arisen from the specific substituted energy source, electricity.

LHV = Lower Heating Value [e.g. MJ/kg] of the material in the product that is used for energy recovery. This should be determined with an appropriate laboratory method.

XER,heat [dimensionless] = the efficiency of the energy recovery process (0<XER<1) for both heat, i.e. the ratio between the energy content of output (e.g. output of heat or electricity) and the energy content of the material in the product that is used for energy recovery. XER shall therefore take into account the inefficiencies of the energy recovery process (0=<XER<1).

XER,elec [dimensionless] = the efficiency of the energy recovery process (0<XER<1) for electricity, i.e. the ratio between the energy content of output (e.g. output of heat or electricity) and the energy content of the material in the product that is used for energy recovery. XER shall therefore take into account the inefficiencies of the energy recovery process (0=<XER<1).

Qs = quality of the secondary material, i.e. the quality of the recycled or reused material

Qp = quality of the primary material, i.e. the quality of the virgin material

Specific data shall be used for post-consumer recycled content (R_1). Post-consumer recycled content is 0% if this company-specific is not available.

Default data for waste packaging and treatment is provided in Table 21 and Table 22. The source of this data is the document "Default data for End of Life (EOL), version 1.2" prepared in the context of the PEF pilots.

Table 21 – Default data for the EoL of plastic and cardboard

Packaging material	Recycling (R_2)	Incineration (R_3)	Landfill ($1-R_2-R_3$)	LHV (MJ/kg)
Plastic	0.353	0.274	0.373	30.8
Carboard	0.838	0.069	0.093	15.9

Table 22 –Default data for EoL logistic

Parameter	Transport modality	Distance (km)
Transport to disposal or incineration	Municipal waste collection truck	30
Transport to recycling	Truck	100

Energy recovery shall be considered for incineration, with default recovery rates of 10% as electricity and 20% as heat.

Qs/Qp is a term from the end of life formula that must reflect the quality of recovered material compared to virgin material.

Default value for Qs/Qp ratio are reported in Table 23.

Table 23 – Default value for Qs/Qp ratio provided by the Euroean Commission

Material	Default value	Comment
Paper and cardboard	0.85	Ratio is based on the input weight of humid fibres and output weight of humid paper. Recycling degrades fibres quality (shorter). However, recycling process eliminates too short fibers, which affects the recycling efficiency. If the process already takes into account fiber losses, Qs/Qp should be 1.
PP	1	-
LDPE film	0.75	Due to impurities in the recycled LDPE, films made out of recycled LDPE usually must be 30% thicker (saving 100/130 : 77% ≈ 75%). For example plastic bag recycling (source: EF helpdesk experience). For other applications like tubes this value can be 0%.

The Crosscutting Working Packaging Working Group (PWG) is currently working to identify a number of 'default' secondary End of Life datasets, available in public/commercial databases, or newly created. Indications from the PWG will be reported in the section about the End of Life of the final version of the PEFCR.

5.4 DATA GAPS

According to the PEF guide, data gaps exist when there is no specific or generic data available that is sufficiently representative of the given process in the product's life cycle.

When modelling the life cycle of dry pasta, if no primary data are available, semi-specific or generic data can be used according to the recommendation given in this document. No data gaps are therefore foreseen.

However, for some ingredients (e.g. spices) there may be no secondary data available. In such cases, according to the PEF guide, data gaps shall be filled using the best available generic or extrapolated data. The contribution of such data (including gaps in generic data) shall not account for more than 10% of the overall contribution to each EF impact category considered. This is reflected in the data quality requirements, according to which 10% of the data can be chosen from the best available data (without any further data quality requirements).

5.5 REQUIREMENTS FOR MULTIFUNCTIONAL PRODUCTS AND MULTIPRODUCT PROCESSES ALLOCATION

The PEF guide provides guidance on handling multi-functional products and multiproduct processes. According to the guide systems involving multi-functionality of processes shall be modelled in accordance with the following decision hierarchy:

1) Subdivision or system expansion
2) Allocation based on a relevant underlying physical relationship
3) Allocation Based on Some Other Relationship

According to the PEF guide additional guidance can be provided in the PEFCR.

The multi-output processes individuated in the life cycle of dry pasta are those reported in Table 24.

Table 24 - By-products/co-products considered in the different processes

Process	Main product	By-products/co-products
Cereals cultivation	Grain	Straw
Eggs production	Eggs	Hens for slaughter
Milling	Semolina/flour	Bran, germ, middling
Pasta production	Pasta	Pasta scraps

When modelling the life cycle of dry pasta, the following decision hierarchy shall be followed in case of multi-functionality:

1) wherever possible, allocation should be avoided by dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes; system expansion should be avoided because it can lead to arbitrary choices.
2) where allocation cannot be avoided, the inputs and outputs of the system shall be partitioned between its different products according to the methods reported in Table 25.

915

916 Table 25 – Allocation methods to be used

Process	Allocation	Justification
Cereals cultivation	Economic	The mass of straw can be equal or even higher than the mass of grain, which would lead to allocation of a relatively large amount of the impact to the co-product. Mass allocation could therefore lead to unrealistic results. Economic allocation is in this case the only allocation option which makes sense in this case, even if it is the last in the PEF hierarchy.
Eggs production	By mass	According to the PEF guide, where subdivision or system expansion cannot be applied the inputs and outputs of the system should be partitioned between its different products or functions in a way that reflects relevant underlying physical relationships between them. Mass allocation is in this case the system to be preferred, since it lead to realistic results starting from easily collectable data.
Milling	By mass	
Pasta production	By mass	

917

918 Specific data shall be collected for the calculation of the allocation factors. If such data are not
919 available default factors reported in Table 26 shall be used.

920

921 Table 26 - Default allocation factor to be used in case no primary data are available

Process	Main product	Allocation	Default allocation factor for the main product	Source
Cereals cultivation	Grain	Economic	100%	Worst case scenario. Straw is not sold, all the environmental burden to grain.
Eggs production	Eggs	By mass	94%	Agri-footprint v. 1.0
Milling	Semolina/flour	By mass	74%	Agri-footprint v. 1.0
Pasta production	Pasta	By mass	98%	Technical Secretariat

922

923 In case of multi-product processes other than that reported in Table 24, the hierarchy reported in the
924 PEF guide shall be followed:

925 1) Subdivision
926 2) Allocation based on a relevant underlying physical relationship
927 3) Allocation Based on Some Other Relationship

928

6. BENCHMARK AND CLASSES OF ENVIRONMENTAL PERFORMANCE

This section will be completed at a later step of the PEFCR development process.

7. INTERPRETATION

This section will be completed at a later step of the PEFCR development process.

8. REPORTING, DISCLOSURE AND COMMUNICATION

This section will be completed at a later step of the PEFCR development process.

9. VERIFICATION

This section will be completed at a later step of the PEFCR development process.

10. REFERENCE LITERATURE

De Schryver, Galatola, Goedkoop, Kougoulis (2015)	Guidance and requirements for handling the use stage in PEFCRs (version 1.1)
European Commission (2012)	Product Environmental Footprint (PEF) Guide
European Commission (2004)	European Commission (2014). Guidance for the implementation of the EU Product Environmental Footprint (PEF) during the Environmental Footprint (EF) Pilot Phase, v. 4.0, May 2014.
European Commission (2015)	Default data for End Of Lie (version 1.2)
Humbert, Guignard (2015)	PEF / OEF : Default data to be used to model distribution, storage and use stage (Version: March 1ST, 2015)
The International EPD System (2013)	The International EPD System (2013). Product Category Rules 2010:01 Uncooked pasta, not stuffed or otherwise prepared (Version 2.01)
The International EPD System (2013)	The International EPD System (2013). Product Category Rules 2013:05 Arable crops (Version 1.01)

11. SUPPORTING INFORMATION FOR THE PEFCR

This section will be completed at a later step of the PEFCR development process.

12. LIST OF ANNEXES

This section will be completed at a later step of the PEFCR development process.

12.1 ANNEX I: REPRESENTATIVE PRODUCT

REPRESENTATIVE PRODUCT

The Technical Secretariat performed an analysis on the European market to individuate the representative product. One of the main issue was the lack of EU overall data. Data available about production, consumption, export and import in the main pasta producing and consuming countries are reported in Figure 15.

Figure 15 – Pasta market in the main European countries in 2013 (Source: UNAFPA)

	Austria	Belgium	Czech Republic	France [1]	Germany	Greece	Italy [3]	Netherlands [5]	Portugal	Spain	Sweden [6]	United Kingdom [7]
Manufacturers	n.a.	1	2	8	20	4	120	1	1	7	1	8
Employees	n.a.	n.a.	300	1,121	2,000	n.a.	7,500	57	n.a.	n.a.	35	n.a.
Production (tons)	n.a.	n.a.	70,000	241,573	[2] 334,179	170,000	3,408,499	23,335	77,500	260,288	20,200	35,000
Export (tons)	52,437	[4] 136,306	[4] 36,036	32,639	42,131	55,324	1,901,354	[4] 34,469	[4]15,694	40,326	[4] 6,775	[4] 10,911
- Third countries	2,710	4,240	498	14,380	10,760	18,925	641,927	2,222	6,225	4,184	4,933	708
- U.E.	49,727	132,066	35,540	18,259	31,995	36,399	1,259,426	32,247	9,469	36,142	1,842	10,203
Import (tons)	64,830	[4] 81,973	[4] 29,800	307,419	359,846	12,077	35,959	[4] 100,197	[4]21,916	31,654	[4] 54,212	[4]169,989
- Third countries	11,281	4,127	1,061	12,283	10,760	533	3,405	6,221	325	3,771	2,648	6,819
- U.E.	53,549	77,846	28,739	295,136	349,086	11,544	32,554	93,976	21,591	27,883	51,564	163,170
Total consumption (tons)	n.a.	n.a.	60,000	512,465	[2] 654,371	127,000	1,507,145	n.a.	70,000	251,616	81,000	135,000
Per capita consumption (kg)	[8] 5.6	n.a.	6.0	8.1	[2] 8.0	11.5	25.3	n.a.	6.7	5.3	9.0	2.5
Raw materials:												
- wheat (tons)	n.a.	n.a.										n.a.
- durum wheat	-	-	20%	367,244	500,000	255,000	4,300,000	10,112	100,500	369,608	11,900	-
- soft wheat	-	-	70%	-	-	-	-	12,774	-	-	8,800	-
- eggs (tons)	n.a.	n.a.	10%	8,127	46,000	60	111,500	-	n.a.	2,180	n.a.	n.a.

Pasta imported from non EU countries represents the 2% of the amount consumed (Source of Data: Eurostat/Global Trade Atlas). In the study production of pasta outside Europe will not therefore be considered, but it's reasonable to estimate that technologies used are not so different from those used in Europe.

Data for the definition of the representative product were asked to all the national associations of pasta producers. Some production data were available also from all the countries, but some were found available only from Italy. Since the 81% of pasta consumed in Europe is produced in Italy, they can be considered representative for the EU market. The experts of the TS agreed that there are not relevant differences of technologies between Italy and the other European countries.

978 Figure 16 – Dry pasta production in Italy in 2013 (Source: AIDEPI)

	Amount (tons)	Economic value (million €)	Sales share
Dry semolina pasta	2.972.064	3.122	88%
Dry egg pasta	165.047	435	12%
Total	3.137.111	3.557	100%

979

980 The two main typologies of dry pasta produced are dry pasta from durum wheat semolina (without
981 eggs) and dry egg pasta. Their shares considering Italian production are those reported in Figure 16.

982 The Technical Secretariat, based on data about raw materials consumption reported in Figure 15,
983 agreed on the fact that most of the dry egg pasta in Europe is made with durum wheat semolina.

984 It was therefore estimated that a little share of the whole European production is made with soft
985 wheat flour (in Italy by law pasta can be made only with durum wheat, but in other countries there is
986 not this limitation). Using the information of raw materials consumption reported in Figure 15 this
987 share was estimated to be 1% of the total dry pasta production.

988 According to the guidance for PEFCR development:

989 the representative product represents all products covered by the PEFCR. The representative product
990 may or may not be a real product that one can buy on the EU market. When the market is made up of
991 different technologies, the “representative product” may be a virtual (non-existing) product with the
992 average EU sales-weighted characteristics of all technologies around. The representative product is
993 the basis of the PEF screening which provides insight into the relevant life cycle stages, processes and
994 impact categories of the product category (including the identification of processes for which primary
995 data are requested).

996 The TS decided to individuate a single virtual representative product, since relevant differences
997 among technologies were not individuated to justify the definition of different representative
998 products.

999 The representative product is therefore be a single virtual product, constituted by the main typologies
1000 of dry pasta weighted according to their share in the market (Figure 17). The main typologies are:

1001 - pasta made with durum wheat semolina;
1002 - pasta made with soft wheat flour;
1003 - egg pasta (mainly made with durum wheat semolina).

1004

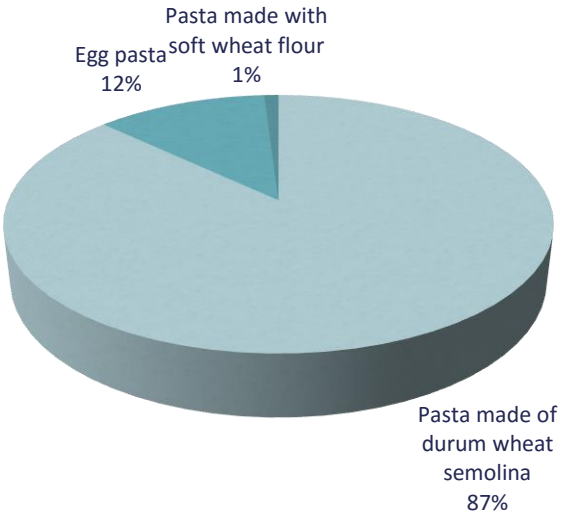


Figure 17 - Market shares of the different typologies of pasta (Source: AIDEPI, IRI, ACNielsen)

The model used for the analysis is represented in Figure 18. Packaging production, distribution, cooking and EoL of packaging are considered to be independent on the type of pasta.

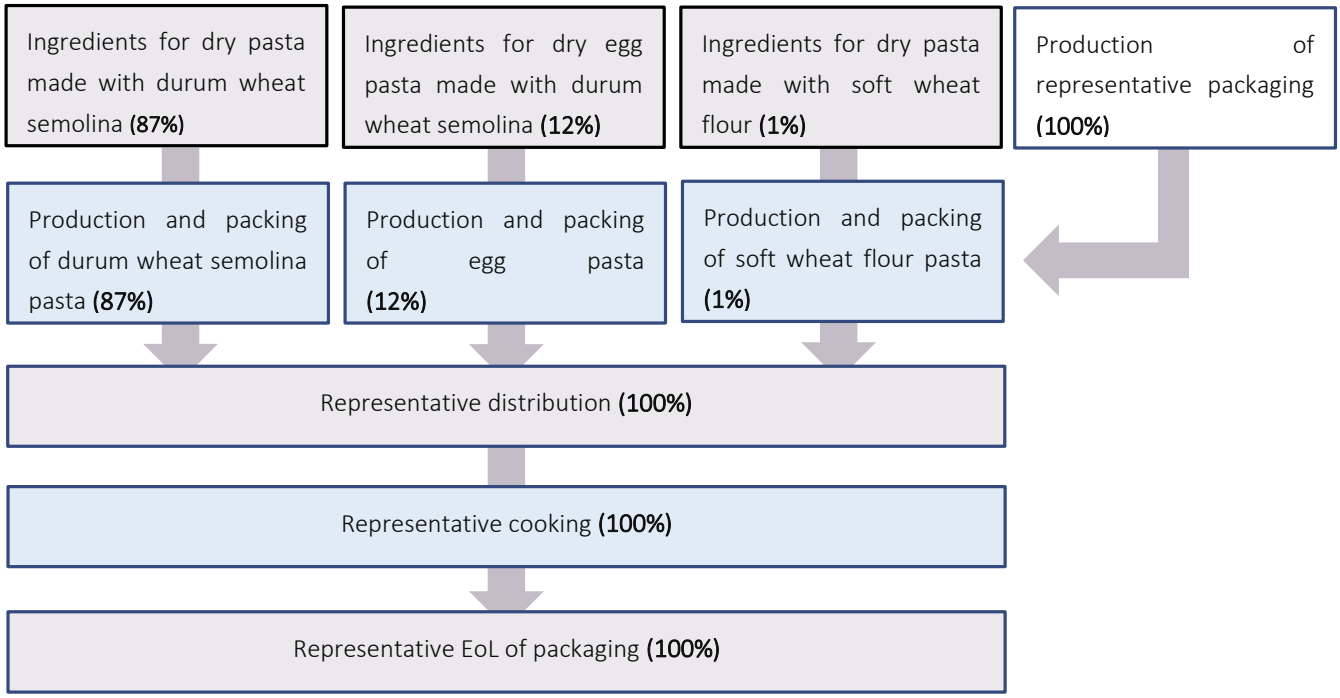

Ingredients for dry pasta made with durum wheat semolina (87%)
Ingredients for dry egg pasta made with durum wheat semolina (12%)
Ingredients for dry pasta made with soft wheat flour (1%)
Production of representative packaging (100%)
Production and packing of durum wheat semolina pasta (87%)
Production and packing of egg pasta (12%)
Production and packing of soft wheat flour pasta (1%)
Representative distribution (100%)
Representative cooking (100%)
Representative EoL of packaging (100%)

Figure 18 – Representative product model

INGREDIENTS

In Figure 19 the lists of ingredients for the main typologies of pasta are reported. These are standard value confirmed by the experts of the TS.

	Pasta made of durum wheat semolina	Pasta made with soft wheat flour	Egg pasta
Durum wheat semolina (kg/kg of pasta)	1,05		0,981
Soft wheat flour (kg/kg of pasta)		1,05 (Soft wheat)	
Eggs without shells or liquid egg product (kg/kg of pasta)			0,147

Figure 19 – List of ingredients

To produce 1 kg of pasta more than 1 kg of ingredients is needed. This because semolina and flour have a moisture content of about 15%, eggs of about 65%, while dry pasta of about 13%. In the production process, in fact, water is added in the kneading phase but it is also evaporated during the drying phase to reach the final moisture content as defined by the different national laws.

PACKAGING

The most common types of pack for pasta are the cardboard box and the plastic film pack. A representative packaging was estimated by the experts of the Technical Secretariat taking into account the sales data of the companies of the TS and reported in Figure 20.

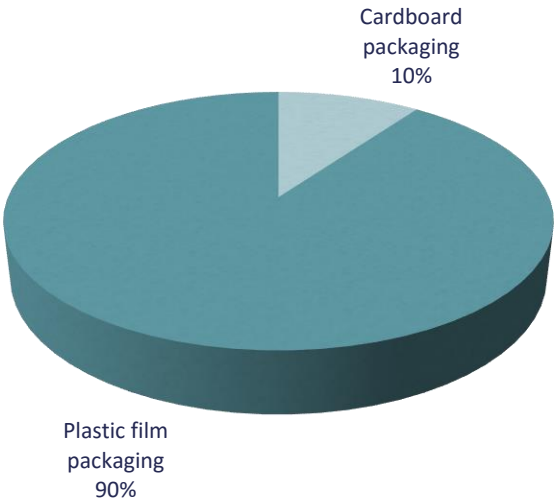


Figure 20 – Representative primary packaging

COOKING

Cooking is considered in the use stage.

The hypothesis considered for energy requirements are those reported in the IES PCR in the paragraph 9.1[12] :

- Boiling phase: 0,18 kWh per kg of water;
- Cooking phase: 0,05 kWh per minute of cooking.

The default scenario is:

- the cooking in a stainless steel pot of 500 g of pasta at a time;
- the use of 1 litre of water for 100 g of pasta;
- a cooking time of ten minutes.

For cooking electricity or gas can be used. Since data about the whole EU were not available, a representative way of cooking was elaborated by the TS considering statistics for the five main pasta consuming countries (Italy, France, Germany, Spain, UK) reported in Figure 21.

In these five countries the 90% of European pasta consumption occur.

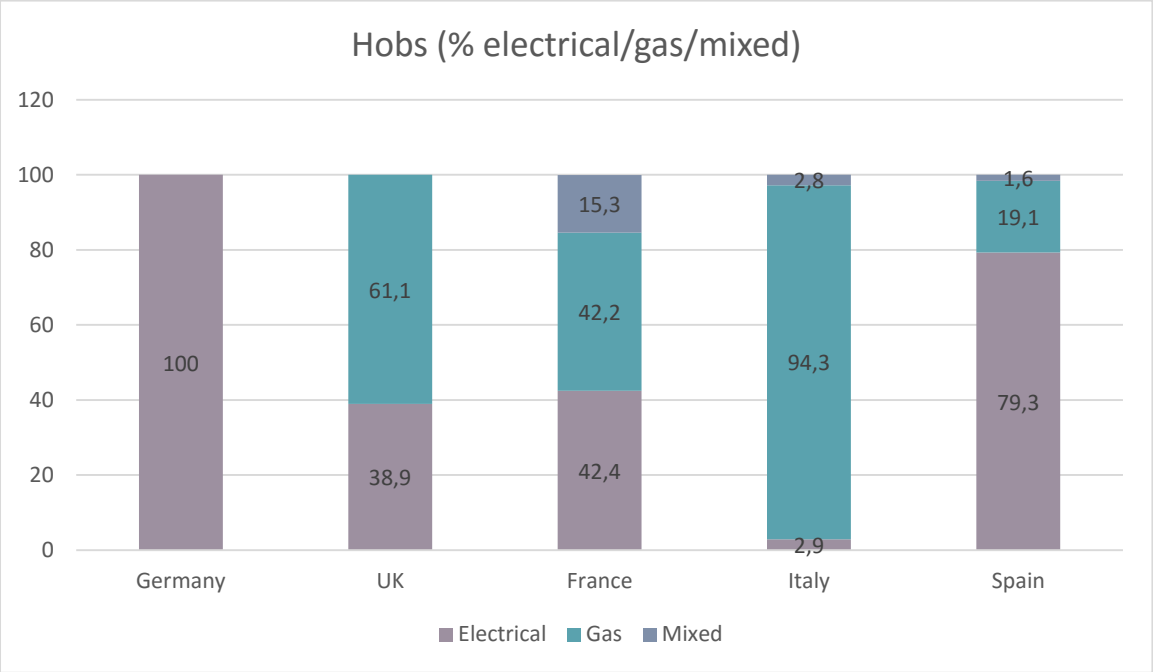


Figure 21 – Energy sources for hobs in the five main EU pasta consuming countries (Source: *GFK, 2006. Sales trend in cooking and other Major Domestic Appliances in an enlarged Europe*)

It was hypothesized that for mixed hobs gas is primarily used.

[12] The International EPD System (2013). Product Category Rules 2010:01 Uncooked pasta, not stuffed or otherwise prepared (Version 2.01)

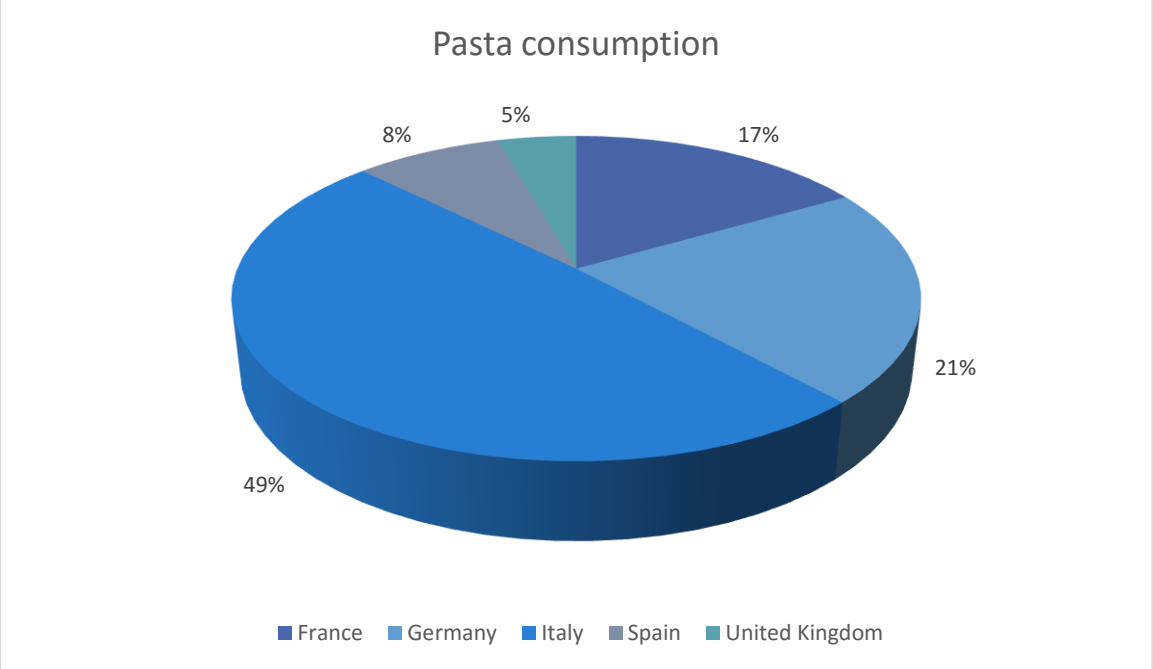


Figure 22 - Pasta consumption in five considered countries

Weighting the information of Figure 21 for the consumption share reported in Figure 22 it is obtained that on average 83% of the pasta consumed in Europe is cooked with gas and 17% with electricity.

13. ANNEX II: SUPPORTING STUDIES

[This section will be completed at a later step of the PEFCR development process.]

14. ANNEX III: BENCHMARK AND CLASSES OF ENVIRONMENTAL PERFORMANCE

[This section will be completed at a later step of the PEFCR development process.]

15. ANNEX IV: NORMALISATION FACTORS

In Table 27 data the normalization factors provided in the Guidance for the implementation of the EU PEF during the EF pilot phase (version 4.0) are reported.

1074 Table 27 – Recommended Normalisation factors for EU 27 (2010) based on domestic inventory

Impact category	Unit	Domestic	Normalisation factor per person (domestic)
Climate change	kg CO2 eq	4.55E+12	9.10E+03
Ozone depletion	kg CFC-11 eq	1.08E+07	2.16E-02
Human toxicity – cancer effect	CTUh	1.84E+04	3.68E-05
Human toxicity – non cancer effect	CTUh	2.66E+05	5.32E-04
Acidification	mol H+ eq	2.36E+10	4.72E+01
Particulate matter	kg PM2.5 eq	2.41E+09	4.82E+00
Freshwater Ecotoxicity	CTUe	4.36E+12	8.71E+03
Ionizing radiations	kg U235 eq	5.64E+11	1.13E+03
Photochemical ozone formation	kg NMVOC eq	1.59E+10	3.18E+01
Terrestrial eutrophication	molc N eq	8.73E+10	1.74E+02
Freshwater eutrophication	kg P eq	7.41E+08	1.48E+00
Marine eutrophication	kg N eq	8.42E+09	1.68E+01
Land use	kg C deficit	3.15E+14	6.30E+05
Resource depletion water	kg water eq	3.95E+10	7.89E+01
Mineral, fossil & renewable resource depletion	kg Sb eq	5.03E+07	1.00E-01

1075

1076

16. ANNEX V: WEIGHTING FACTORS

No weighting approaches alternative to the baseline one (i.e. all impact categories shall receive the same weight) were tested at this stage of the PEFCR development process.

17. ANNEX VI: FOREGROUND DATA

[This section will be completed at a later step of the PEFCR development process.]

18. ANNEX VII: BACKGROUND DATA

SOURCES OF BACKGROUND DATA

The sources of background data reported in Table 28 can be used in PEF studies.

Table 28 - Sources of background data

Process	Source of secondary data
Cereals cultivation	Agri-balyse; Agri-footprint; Ecoinvent
Milling	Agri-footprint (mass allocation)
Eggs production	Agri-footprint (mass allocation)
Packaging production	Plastics Europe for plastic; Ecoinvent for the other materials
Logistics	Agri-footprint
Energy	ELCD

In Table 29 a list of datasets that can be used to model cereals cultivation is reported.

Table 29 – Sources of datasets for cultivation of the main crops

Cereal	Available dataset	Database	Production System	Country	Year	Allocation
Durum wheat	Durum wheat grain, conventional, national average, at farm gate/kg/FR	AgriBalyse	Conventional	France	2005-2009	No allocation
Soft wheat	Soft wheat grain, conventional, national average, at farm gate/kg/FR	AgriBalyse	Conventional	France	2005-2009	No allocation

Soft wheat	Soft wheat grain, conventional, protein improved quality, 15% moisture, at farm gate/kg/FR	AgriBalyse	Conventional	France	2005-2009	No allocation
Soft wheat	Wheat grains, at farm/US U	Ecoinvent	Conventional	USA	2001-2006	Economic
Soft wheat	Wheat grains conventional, Castilla-y-Leon, at farm/ES U	Ecoinvent	Conventional	Spain	2000-2004	Economic
Soft wheat	Wheat grain, at farm/UK Economic	Agri-Footprint	Conventional	UK	2005-2009	Economic
Soft wheat	Wheat grain, at farm/FR Economic	Agri-Footprint	Conventional	France	2005-2009	Economic
Soft wheat	Wheat grain, at farm/DE Economic	Agri-Footprint	Conventional	Germany	2005-2009	Economic
Soft wheat	Wheat grains organic, at farm/CH U	Ecoinvent	Organic	Switzerland	1996-2003	Economic

EXAMPLE OF DEVELOPMENT OF A DATASET FOR CULTIVATION STARTING FROM AN EXISTING ONE

If there are no generic datasets for cultivation available (i.e. a DQR ≤3.0 cannot be achieved with the existing ones), it is possible, starting from a secondary dataset, remodel/adapt it to the specific situation (including at least yield, fertilizers use and fertilizers-related emissions) achieving a DQR ≤3.0.

E.g. To produce pasta a company uses durum wheat coming from Canada, Greece, Italy and Turkey, but in available databases there is only a dataset referring to durum wheat cultivation in France (*Durum wheat grain, conventional, national average, at farm gate/kg/FR* from the database AgriBalyse). In this case the company can substitute in the existing dataset data about yield, fertilizers use and fertilizers emissions with data referred to the situation of the different countries.

Source of data about yield: European Commission (Eurostat and DG Agriculture and Rural Development) and International Grains Council, average years 2009-2012.

Source for the amount of fertilizers: technical handbook for cultivation “Manuale di agricoltura”, published by Hoepli.

Emissions from fertilizers use calculated with the emission factors reported in the PCR 2013:05 Arable crops (Version 1.01) of the International EPD system available at: http://www.environdec.com/en/PCR/Detail/?Pcr=8804&id=158&epslanguage=en#.VlLP-vkveUk. The sources of the emission factors are reported in Table 31.

1119 Table 30 - Example of development of a dataset for cultivation starting from an existing one. Cells
1120 with modified values are highlighted in yellow.

	Durum wheat grain, conventional, national average, at farm gate/kg/FR	New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/CA	New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/GR	New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/IT	New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/TR	Unit
Product						
Durum wheat grain, conventional, national average, at farm gate/kg/FR U	4759	2475	2598	3125	3300	kg
Resources						
Water, river	181,25	181,25	181,25	181,25	181,25	m3
Occupation, arable	9095,89	9095,89	9095,89	9095,89	9095,89	m2a
Materials/fuels						
Durum wheat grain, conventional, national average, at farm gate/kg/FR U	45,26	45,26	45,26	45,26	45,26	kg
Durum wheat seed, conventional, national average, at farm gate/kg/FR U	100,74	100,74	100,74	100,74	100,74	kg
Ammonium nitrate, as N, at regional storehouse/RER U	142,746	39	41	49	52	kg
Urea, as N, at regional storehouse/RER U	36,254	39	41	49	52	kg
Average mineral fertilizer, as K2O, at regional storehouse/kg/FR U	18	18	18	18	18	kg
Average mineral fertilizer, as P2O5, at regional storehouse/kg/FR U	38	40	42	50	53	kg
Pesticide unspecified, at regional storehouse/RER U	0,073	0,073	0,073	0,073	0,073	kg
Nitrile-compounds, at regional storehouse/RER U	0,0073	0,0073	0,0073	0,0073	0,0073	kg
Cyclic N-compounds, at regional storehouse/RER U	0,0073	0,0073	0,0073	0,0073	0,0073	kg
[sulfonyl]urea-compounds, at regional storehouse/RER U	0,014273	0,014273	0,014273	0,014273	0,014273	kg
Pesticide unspecified, at regional storehouse/RER U	0,028998	0,028998	0,028998	0,028998	0,028998	kg
Acetamide-anillide-compounds, at regional storehouse/RER U	0,00196	0,00196	0,00196	0,00196	0,00196	kg
Glyphosate, at regional storehouse/RER U	0,072	0,072	0,072	0,072	0,072	kg
Cyclic N-compounds, at regional storehouse/RER U	0,275675	0,275675	0,275675	0,275675	0,275675	kg

	Durum wheat grain, conventional, national average, at farm gate/kg/FR	**New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/CA**	**New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/GR**	**New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/IT**	**New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/TR**	Unit
Dinitroaniline-compounds, at regional storehouse/RER U	0,07745	0,07745	0,07745	0,07745	0,07745	kg
Benzimidazole-compounds, at regional storehouse/RER U	0,06942	0,06942	0,06942	0,06942	0,06942	kg
Pyretroid-compounds, at regional storehouse/RER U	0,003648	0,003648	0,003648	0,003648	0,003648	kg
Pesticide unspecified, at regional storehouse/RER U	0,54288	0,54288	0,54288	0,54288	0,54288	kg
Electricity, low voltage, at grid/FR U	181,25	181,25	181,25	181,25	181,25	kWh
Soil maintenance, with cover crop 4m/hr/FR U	0,38	0,38	0,38	0,38	0,38	hr
Harrowing, with vibrating tine cultivator (standard equipment) 5m/hr/FR U	0,215517	0,215517	0,215517	0,215517	0,215517	hr
Soil decompactation, with 4.5m chisel/hr/FR U	0,1125	0,1125	0,1125	0,1125	0,1125	hr
Rolling, with roller 9m/hr/FR U	0,06	0,06	0,06	0,06	0,06	hr
Ploughing, with 5 or 6 soc plough/hr/FR U	0,586667	0,586667	0,586667	0,586667	0,586667	hr
sowing or planting, with classic seeder and harrow/hr/FR U	0,816667	0,816667	0,816667	0,816667	0,816667	hr
Sowing or planting, direct seeding/hr/FR U	0,0084	0,0084	0,0084	0,0084	0,0084	hr
Fertilizing, with spreader, 2500 l/hr/FR U	0,409639	0,409639	0,409639	0,409639	0,409639	hr
Fertilizing or plant protection, with sprayer, 2500 l/hr/FR U	0,296	0,296	0,296	0,296	0,296	hr
Harvesting, with combine harvester/hr/FR U	0,666667	0,666667	0,666667	0,666667	0,666667	hr
Transporting to farm, with 2 axle trailer (15 t)/hr/FR U	0,67	0,67	0,67	0,67	0,67	hr
Transport, lorry >16t, fleet average/RER U	89,5125	89,5125	89,5125	89,5125	89,5125	tkm
Transport, transoceanic freight ship/OCE U	299,373	299,373	299,373	299,373	299,373	tkm
Transporting to farm, with 2 axle trailer (15 t)/hr/FR U	0,037217	0,037217	0,037217	0,037217	0,037217	hr

Emissions to air

	Durum wheat grain, conventional, national average, at farm gate/kg/FR	New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/CA	New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/GR	New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/IT	New dataset - Durum wheat grain, conventional, national average, at farm gate/kg/TR	Unit
Ammonia	10,0701	8.1	8,5	10.1	10.7	kg
Nitrogen oxides	4,43838	1.1	1,1	1,4	1,4	kg
Dinitrogen monoxide	3,84505	1,4	1,5	1,8	1,9	kg
Carbon dioxide, fossil	57,7962	61	64	77	82	kg
Emissions to water						
Phosphorus	0,608353	0.49	0.49	0.50	0.50	kg
Cadmium	3,78E-05	3,78E-05	3,78E-05	3,78E-05	3,78E-05	kg
Copper	0,001108	0,001108	0,001108	0,001108	0,001108	kg
Zinc	0,005878	0,005878	0,005878	0,005878	0,005878	kg
Lead	2,73E-05	2,73E-05	2,73E-05	2,73E-05	2,73E-05	kg
Chromium	0,015926	0,015926	0,015926	0,015926	0,015926	kg
Mercury	4,34E-06	4,34E-06	4,34E-06	4,34E-06	4,34E-06	kg
Cadmium	0,000169	0,000169	0,000169	0,000169	0,000169	kg
Copper	0,004538	0,004538	0,004538	0,004538	0,004538	kg
Zinc	0,008746	0,008746	0,008746	0,008746	0,008746	kg
Lead	0,000942	0,000942	0,000942	0,000942	0,000942	kg
Nickel	0,005444	0,005444	0,005444	0,005444	0,005444	kg
Chromium	0,029174	0,029174	0,029174	0,029174	0,029174	kg
Mercury	1,84E-05	1,84E-05	1,84E-05	1,84E-05	1,84E-05	kg
Nitrate	137,286	104	109	130	138	kg
Emissions to soil						
Cadmium	0,00037	3,78E-05	3,78E-05	3,78E-05	3,78E-05	kg
Copper	-0,00861	0,001108	0,001108	0,001108	0,001108	kg
Zinc	-0,02092	0,005878	0,005878	0,005878	0,005878	kg
Lead	-0,00061	2,73E-05	2,73E-05	2,73E-05	2,73E-05	kg
Nickel	-0,00416	0,015926	0,015926	0,015926	0,015926	kg
Chromium	-0,03694	4,34E-06	4,34E-06	4,34E-06	4,34E-06	kg
Mercury	3,48E-05	0,000169	0,000169	0,000169	0,000169	kg
Anthraquinone	0,073	0,004538	0,004538	0,004538	0,004538	kg

Table 31 – Source of the emissions factors for fertilizers use reported in the PCR 2013:05 Arable crops (Version 1.01) of the International EPD system

	EMISSION	SOURCE
Emissions to air	Ammonia	EMEP/CORINAIR Emission Inventory Guidebook - 3rd edition October 2002
	N2O, NO – direct emission	Bouwman, A. F., L. J. M. Boumans, and N. H. Batjes, 2002, Modeling global annual N2O and NO emissions from fertilized field
	N2O – indirect emission	IPCC, 2006. Guidelines for National Greenhouse Gas Inventories
Emissions to water	Nitrates	IPCC, 2006. Guidelines for National Greenhouse Gas Inventories
	Phosphorus	Prahsun V., 2006. Erfassung der PO4-Austrage fur die Okobilanzierung SALCA Phosphor. Agroscope Reckenholz – Tanikon ART, 20p

19. ANNEX VIII: EOL FORMULAS

No additional EOL formulas were tested at this stage of the PEFCR development process.

20. ANNEX IX: BACKGROUND INFORMATION ON METHODOLOGICAL CHOICES TAKEN DURING THE DEVELOPMENT OF THE PEFCR

[This section will be completed at a later step of the PEFCR development process.]